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Регулювання в управлінні підприємницькими ризиками на засадах положень концепції сталого розвитку для будівельного підприємства

Regulation in Business Risk Management Based on the Provisions of the Concept of Sustainable Development for a Building Enterprise

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Анотація. У статті розкрито питання, що стосуються особливостей регулювання в управлінні підприємницькими ризиками на засадах положень концепції сталого розвитку для будівельного підприємства. За результатами проведеного дослідження запропоновано принципи підвищення ефективності реалізації інвестиційного проекту будівельного підприємства з урахуванням ризиків в умовах сталого розвитку. При цьому особливо актуальним для будівельних підприємств є аналіз показників, які характеризують оцінювання ефективності та якості інвестицій в системі інвестиційних проектів з урахуванням ризиків. Сформульовано оптимізаційну задачу щодо забезпечення стійкості портфеля проектів для будівельного підприємства з урахуванням 4-х систем проектів, які є складовими портфеля і орієнтовані на: адаптацію технологічного процесу; інтеграцію мереж зв'язків як об'єктів проектування; уніфікацію документації нормативно-технічного забезпечення (регламентів та стандартів); модернізацію системи цінностей сталого розвитку.

Ключові слова: будівельне підприємство; інвестиційні проекти; регулювання; оптимізація; якість; ефективність; інвестиції; підприємницькі ризики; стандарти; сталий розвиток.

Abstract. The article deals with the issues related to the peculiarities of regulation in business risk management, based on the concept of sustainable development for the building enterprise. According to the research results, the principles of increasing the efficiency of implementation of the investment project of the building enterprise, taking into account the risks in the conditions of sustainable development, are proposed. At the same time, the analysis of indicators that characterize the evaluation of the efficiency and the quality of investments in the system of investment projects, taking into account risks, is especially relevant for building enterprises. An optimization task was formulated to ensure the sustainability of the project portfolio for the building enterprise, taking into account the four project systems, which are components of the portfolio and are focused on: adaptation of technological process; integration of communication networks as design objects; unification of regulatory and technical support documentation (regulations and standards); modernization of the system of sustainable development values.

Keywords: building enterprise; investment projects; regulation; optimisation; quality; efficiency; investments; business risks; standards; steel development.

ВСТУП

Прогнозування і реалізація будь-яких інвестиційних проектів в умовах нестабільного розвитку будівельних підприємств є однією із важливих проблем та пріоритетних завдань сучасної економіки України. При цьому важливого значення набувають актуальні практичні питання, які безпосередньо пов'язані з розвитком проектів в умовах сталого розвитку, для врахування безпекових питань і ризиків у майбутньому [1, 2]. Тут також необхідно зазначити, що керування проектами в будівельній сфері передбачає опрацювання великого обсягу елементів і даних, має досить складну структуру їх взаємодії, а також включає систему відповідних внутрішніх та зовнішніх взаємозв'язків, з урахуванням підприємницьких ризиків [3, 4, 5, 6, 7, 8].

Водночас відомо, що в таких умовах для забезпечення ефективного соціально-економічного чи суто технічного проекту потрібно удосконалювати спочатку процеси керування його окремими елементами з урахуванням сучасних підходів, а на другому етапі – удосконалювати проект у цілому з урахуванням ризиків тощо. В той же час, процедуру керування доцільно розглядати як важливу функцію виробничої системи, орієнтовану на досягнення певної мети з відповідними завданнями, які повинні у сукупності забезпечити стійкість функціонування проекту в умовах невеликих відхилень відносно умов сталого розвитку, враховуючи при цьому безпекові питання і ризики у майбутньому. Тут також необхідно врахувати той факт, що з різними умовами функціонування проекту пов'язані проблеми допустимих меж ризику інвестицій.

Враховуючи наведене вище, очевидно, що дослідження особливостей регулювання в управлінні підприємницькими ризиками для будівельного підприємства на засадах положень концепції сталого розвитку є досить актуальною проблемою.

Аналіз останніх досліджень і публікацій свідчить про те, що засадничі основи відповідних критеріїв і параметрів стосовно ефективності проекту можуть частково забезпечити підходи фінансової (актуарної) математики [9, 10, 11, 12, 13, 14]. Проекти, що формуються на основі розробок оптимізаційної теорії і актуарної (фінансової) математики, можуть бути науково обґрунтованими і ефективними. Ва-

жливе значення в цьому напрямку належить заходам регулювання технологічного ризику [15, 16, 17, 18, 19, 20].

З наведеного економічного аналізу заходів безпеки в умовах ризику випливає, що заходи і напрями безпеки будівельного підприємства (далі – БП) регулюються ризиками, а у випадку інцидентів доцільно забезпечити оптимальний моніторинг технічного регулювання як механізму управління у будівництві для зниження загальних ризиків під час будівництва та подальшої експлуатації будівель і споруд для реалізації права громадян на безпеку для життя і здоров'я довкілля та за умов одночасного забезпечення сприятливого правового поля для розвитку бізнесу, зменшення фінансових втрат, а також залучення та захисту інвестицій і забезпечення стійкого розвитку територій [15, 17, 18, 19, 21, 22, 23].

Отже, з огляду на викладене вище, *метою статті* є дослідити і розкрити особливості регулювання в управлінні підприємницькими ризиками на засадах положень концепції сталого розвитку для будівельного підприємства.

РЕЗУЛЬТАТИ ДОСЛІДЖЕННЯ

Загальна тенденція інвестиційної політики бізнес-структур свідчить про те, що проекти у кінцевому результаті повинні давати або забезпечувати прибуток, а також його максимізацію. На початкових етапах, як свідчить практика, деякі проекти інвестиційного характеру є затратними, і тільки пізніше дають прибуток. Тут важливим є врахування таких чинників: затримка в реалізації проекту, збільшення капітальних витрат (інвестицій), дефіцит основних виробничих фондів, низька якість сировини, недостатній ринок збуту тощо [24]. З часом, враховуючи думку фахівців і спеціалістів у цьому напрямі, відповідні недоліки можна усунути засобами регулювання і досягнути такої ситуації, за якої загальний дохід будівельного підприємства буде дорівнювати затратам, а потім і перевищить їх.

Для підрахунків прибутковості інвестиційних проектів доцільно використовувати разом з методами актуарної (фінансової) математики науково обґрунтовані оптимізаційні підходи і відповідні оцінки. Найбільш поширеними у такому контексті є оцінювання прибутку за:

чистим дисконтним доходом D ; індексом прибутковості I (рентабельністю); внутрішньою нормою прибутковості – H ; терміном окупності проекту – T ; зведеними витратами – B ; дисконтним прибутком – P [24, 25].

Так, чистий дисконтний дохід D розраховується за формулою (1):

$$D = \sum_{i=N}^T \frac{U_i}{(1+E)^i} - \sum_{i=1}^T \frac{V_i}{(1+E)^i}, \quad (1)$$

де i – крок розрахунку, що еквівалентний одиниці часу; T – величина розрахункового періоду; N – номер кроку, з якого починають надходити прибутки; U_i – прибутки за дії проекту на i -му кроці; V_i – витрати на здійснення проекту на i -му кроці; E – норма дисконту [9, 10, 11, 12].

Розраховуючи за формулою (1) прибуток, варто зауважити, що повинна бути наявною відповідність кроку розрахункового періоду до умов інвестування, тобто – щоб цей крок був рівним або кратним нарахуванню відсотків за кредит [9, 10, 11, 12, 13, 14]. Якщо дисконтний прибуток D прирівнюється сумі потоків платежів, то інвестиційні витрати включаються в потік платежів зі знаком мінус [9, 10, 11, 12].

Облік інвестиційних витрат пов'язаний з оцінюванням всіх витрат, а також враховує особливості позикового капіталу. Для визначення відповідних прибутків та їх складових доцільно врахувати розбіжності у звітних документах підприємств. Компанії у процесі звітування представляють інформацію про величини прибутків і збитків, а також джерела отримання й використання фондів. У звітах щодо фондів та джерел їх використання, в яких фонди грошових коштів формуються за рахунок чистого прибутку, амортизаційних відрахувань, нового акціонерного капіталу, кредитів та інших доходів, фонди використовуються для виплати дивідендів акціонерам, придбання нерухомості, устаткування, обладнання, збільшення обігового капіталу тощо [9, 10, 11, 14]. Це означає, що вільні грошові кошти підприємства повинні раціонально використовуватися для розширення та модернізації виробництва. Оскільки для такого типу підприємств звітність відсутня, то в них амортизаційні відрахування часто залиша-

ються в амортизаційному фонді. Необхідність врахування ліквідної вартості основних виробничих фондів регулюється інвестиціями. Оскільки обладнання з часом замінюється внаслідок використання, то врахування аспектів регулювання його ліквідної вартості є необхідним. Коли ж метою інвестицій є заміна обладнання, то під час оцінювання ефективності інвестицій варто враховувати зміни витраченого капіталу з урахуванням ризиків. Одним з результатів інвестиційної діяльності є ліквідація кредитної заборгованості та реалізація виплат дивідендів акціонерам. Під час укладання проектів варто враховувати, що іноді термін їх виконання може бути суттєво завищеним. Тому потрібно регулювати величину вкладів для позик окремо, а в деяких випадках – проводити відповідну диференціацію суми позик та власних коштів (за бажанням партнерів) для окремих етапів розрахункового періоду. Варто зауважити, що оцінювання за чистим дисконтним доходом може мати наступні особливості: дохід без урахування амортизаційних відрахувань, дохід з урахуванням амортизаційних відрахувань та ліквідної вартості основних виробничих фондів [9, 10, 11, 12, 13, 14]. У процесі оцінювання доходу D (1) потрібно враховувати мету інвестування та технічну політику підприємства в період експлуатації готового об'єкта з урахуванням ризиків в системі цінностей сталого розвитку.

Як відомо, якщо $D > 0$ (1), то такий проект з позиції інвестування можна вважати вартим уваги. Чим більше значення D , тим вищий ризик вкладення капіталу і тим вищі його перспективи.

Важливою оцінкою є індекс прибутковості I , який визначаємо за формулою (2):

$$I = \frac{U}{V + a \cdot \Omega(X_i)}, \quad (2)$$

$$\text{де } U = \sum_{i=N}^T \frac{U_i}{(1+E)^i}; V = \sum_{i=N}^T \frac{V_i}{(1+E)^i};$$

a – постійний параметр, який визначаємо з розв'язку оптимізаційної задачі; $\Omega(X_i)$ – стабілізаційна функція, яка забезпечує стійкість і стабільність інвестиційної діяльності [28]; X_i – параметри логістичної системи (логістична система підприємства (бізнес-

структури) складається з 3-х основних функціональних підсистем, а саме [29]: закупівельної (заготівельної, постачальницької), внутрішньовиробничої та збутової (розподільчої) ($i = 1, 2, 3, \dots iz$).

У формулі (2) використано частину аналогічних позначень, що й у співвідношенні (1). Із формули (2) бачимо, що якщо $I > 1$, то проект можна реалізувати. Чим більше I , тим більша привабливість інвестиційного проекту. Індекс прибутковості I показує у скільки разів дисконтовані доходи перевищують дисконтовані витрати і враховує аспекти регулювання за допомогою стабілізаційної функції. При цьому рентабельність R визначаємо у відсотковому вимірі – формула (3) [9, 10, 11, 12, 14]:

$$R = (BP / C) \times 100. \quad (3)$$

Тут чистий прибуток BP розділено на величину всіх витрат C .

Не менш важливою є внутрішня норма прибутковості H . Вона визначається як розрахункова ставка відсотків, за якою капіталізація регулярно отримуваних доходів дорівнює інвестиціям. Тобто величина H визначається з допомогою умови (4):

$$U = V, \quad (4)$$

звідки – формула (5):

$$\sum_{i=N}^T \frac{U_i}{(1+H)^i} = \sum_{i=N}^T \frac{V_i + a_i \cdot \Omega_i}{(1+H)^i}. \quad (5)$$

У формулах (4), (5) використані аналогічні позначення, що і у співвідношеннях (1)–(2). У (5) враховано компоненти Ω_i стабілізаційної функції Ω .

Під час оцінювання інвестиційного проекту на початку розрахунків були відомі умови інвестування та кредитування, в т. ч. відсотки за кредит. Якщо кредит надається частинами в різні періоди часу від моменту реалізації проекту, то підвищення ставки процентів за кредит приведе до зниження вартості майбутніх надходжень кредиту, дисконтних до моменту початку реалізації проекту. А це, в свою чергу, призведе до підвищення величини

внутрішньої норми прибутковості H . Відсоток за кредит може бути пільговим, а норма дисконту, яка використовується для розрахунків, повинна відповідати середній ставці відсотка за кредит. За власні кошти в результаті реалізації проекту повинні бути виплачені дивіденди, в т. ч. і за час реалізації проекту (з урахуванням надходжень). Тому, під час розрахунку величини H варто враховувати загальний баланс власних коштів, доходів і витрат з урахуванням чистого прибутку і амортизаційних відрахувань. Для знаходження внутрішньої норми прибутковості H розв'язуємо рівняння (5), застосовуючи спеціальні методи актуарної (фінансової) математики [9, 10, 11, 12, 13].

Суттєвим також є такий параметр як термін окупності проекту T . Він визначається як період часу від початку реалізації проекту до моменту експлуатації об'єкта, коли доходи від експлуатації стають рівними затратам. В розрахунках терміну окупності капітальні витрати враховуються в дисконтній сумі витрат на реалізацію проекту, а експлуатаційні витрати входять в собівартість готової продукції і відповідно зменшують суму чистого прибутку в період експлуатації об'єкта. Термін окупності досягається на тому кроці розрахункового періоду, коли величина індексу дохідності вперше перевищує одиницю, тобто коли доходи від реалізації перевищують інвестиційні витрати [9, 10, 11, 12]. Враховуючи інформацію у працях [9, 14, 30], варто зазначити, що зменшення терміну окупності підвищує інвестиційну привабливість проекту.

За собівартістю виробленої продукції C за одиницю часу (одиниця часу, яка використовувалась для визначення терміну окупності T), терміном окупності T (кількістю одиниць часу), капітальними вкладеннями K в об'єкт, нормою ефективності капітальних вкладень E обчислюємо зведені витрати проекту B за формулою (6) [9, 10, 11, 12]:

$$B = C + KE = C + \frac{K}{T}. \quad (6)$$

Можна вважати, підтримуючи точку зору різних фахівців, що зведені витрати виражають галузеву ціну виробництва продукції. Якщо врахувати, що собівартість залежить від капітальних вкладень і обсягу виробництва про-

дукції з різним асортиментом за певних умов, то зведені витрати – це диференціальні показники величини певного приросту щорічних витрат підприємства на одиницю приросту випуску продукції відповідного типу, коли обсяг випуску всіх інших типів та загальний розмір попередніх капітальних вкладень у всьому народному господарстві будуть незмінними.

Для порівняння варіантів з різночасовими витратами використовуємо метод зведення їх до одного року за допомогою коефіцієнта дисконтування $1/(1+E)^i$, тобто:

$$B = \sum_{i=N}^T \frac{B_i}{(1+E)^i}, \quad (7)$$

де B_i – зведені витрати, що відповідають i -му моменту часу;

$$K = \sum_{i=N}^T \frac{K_i}{(1+E)^i}, \quad (8)$$

де K_i – капітальні вкладення в i -му етапі (моменті часу); E – норма ефективності інвестицій (ставка дисконтування).

Врахуємо, що параметр E (формула (9)) залежить від рівня інфляції Inf (у перспективі) та ризику Z [15]:

$$E = RF + Z, \quad RF = (RCB - Inf)/(100 - Inf), \quad (9)$$

де RCB – ставка рефінансування центрального банку.

Дисконтний прибуток визначаємо за допомогою співвідношення (10):

$$P_d = \sum_{i=N}^T \frac{P_{di}}{(1+E)^i}, \quad (10)$$

де P_{di} – прибуток, який відповідає i -му етапу (моменту часу) [9, 10, 11, 12].

Дисконтний прибуток регламентує сумарну вартість прибутку за певний час з урахування вартості прибутку в часі. Чим раніше отрима-

ний прибуток, тим більша його вартість, оскільки його можна раніше використати для отримання додаткового прибутку.

Для обчислення прибутку від декількох об'єктів, для яких здійснюються проекти, необхідним стає оцінювання, що враховує не тільки прибутки P_i від кожного проекту, а і додатковий прибуток, отриманий від спільного здійснення цих проектів (у цьому проявляється суть і зміст синергетичного ефекту):

$$\begin{aligned} P(D, I, R, B, K) &= \\ &= P_1 + P_2 + \dots + P_n + D_s = \sum_{i=1}^n P_i + D_s, \quad (11) \end{aligned}$$

де $P(D, I, R, B, K)$ – загальний прибуток; P_1, P_2, \dots, P_n – прибутки від окремих складових об'єктів; D_s – прибуток від одночасного виконання цих проектів.

Застосуємо систему співвідношень для моделювання процесів типу (1)–(11) до портфеля проектів, які стосуються будівельного підприємства (далі – БП). В даний час основними напрямками європейської інтеграції у сфері будівництва визнані такі [24]: 1) адаптація законодавства України до законодавства Європейського Союзу (далі – ЄС) та відповідні інституційні перетворення (адаптацію технологічного процесу); 2) інтеграція мереж; 3) уніфікація регламентів та стандартів. Поставимо у відповідність цим трьома напрямкам проекти, які входять у портфель проектів. Доповнимо вище поданий перелік четвертою складовою портфеля проектів: 4) удосконалення системи керування проектами засобами регулювання та модернізації технічних об'єктів БП за допомогою стабілізаційної функції Ω та її компонент Ω . Четверта складова передбачає:

а) підхід до процедури моделювання підприємницькими ризиками в системі цінностей сталого розвитку [3, 4, 31];

б) моніторинг процесу керування підприємницькими ризиками в системі цінностей сталого розвитку на основі сучасних інформаційних технологій [5, 6, 7, 20, 32].

Встановлено, що основними завданнями відповідної системи моніторингу портфеля проектів БП будуть:

- організація спостережень і на їх основі отримання достовірної і об'єктивної інформації про хід соціально-економічних процесів у сфері проектів БП України;
- оцінювання і системний аналіз одержаної інформації, виявлення причин, які негативно впливають на функціонування проектного комплексу (БП);
- фінансове забезпечення в установленому порядку органів керування підприємств, установ і організацій, незалежно від їх підпорядкування і форм власності, а громадян –

інформацією, яку одержано під час проведення галузевого моніторингу БП;

- розроблення соціально-економічних прогнозів щодо контролю БП;
- підготовка рекомендацій, спрямованих на подолання негативних і підтримку позитивних тенденцій функціонування БП, доведення їх з допомогою стабілізаційної функції до відповідного рівня.

Для реалізації методики оцінювання ризику Z процесів портфеля проектів БП на основі статистичного підходу вводимо параметр $\Psi(Z)$ та відповідний інтегральний критерій, аналогічно як у праці [25]:

$$\Psi(Z) = \sqrt{(\delta D)^2 + (\delta I)^2 + (\delta R)^2 + (\delta H)^2 + (\delta B)^2 + (\delta K)^2 + (\delta P)^2} \Rightarrow \min. \quad (12)$$

Тут враховано множину непевностей (неозначеностей) показників: $\delta D, \delta I, \delta R, \delta H, \delta B, \delta P$, які є складовими інтегрального ризику Z для вище поданих параметрів D, R, H, B, P згідно формул (1), (2), (4)–(10). Символ δ в (12) означає відносне відхилення відповідного параметра від його нормативного значення, наприклад $\delta D = (D - D_n)/D$, де D_n – нормативне значення параметра.

Для оптимізації інформаційних та фінансових потоків $P_k(X_i)$ і покращення систем захисту підприємств (БП) використаємо, аналогічно як у працях [25, 31, 32], функціонал якості з урахуванням оберненого зв'язку:

$$J(P_k(X_i), FB(X_i), \Omega(X_i)) = \int_{t_0}^{t_k} f(\bar{y}, \bar{u}, \bar{s}) dt \Rightarrow opt, \quad (13)$$

де \bar{y} – вектор заданих впливів ($y_j(t)$ – компоненти вектору, $j = 1, 2, \dots, n$); t – час; \bar{u} – вектор керувань; \bar{s} – вектор невизначених збурень; $[t_0, t_k]$ – інтервал часу, в якому розглядається процес (формування оптимальних значень інформаційних та фінансових потоків $P_k(X_i)$, $k = 1, 2, \dots, m$); m – загальне число інформаційних та фінансових потоків, які мають відношення до підприємств (БП); $f(\bar{y}, \bar{u}, \bar{s})$ – функція,

що відображає показник якості; $FB(X_i)$ – функція, яка характеризує обернений зв'язок (Feed-back) між потоками P_i і оточенням підприємств (контрагентами) з урахуванням думок спеціалістів, експертів. Тут символ opt відповідає умові оптимальності функціоналу.

Для забезпечення виробничо-економічної стійкості портфеля проектів і його 4-х складових частин вводимо інтегральний показник стійкості S у вигляді, що узагальнює відповідні співвідношення і параметри, які частково подані у працях [20, 26, 27]:

$$S = \sum_{r=1}^6 b_r S_r \Rightarrow opt, \quad \sum_{r=1}^6 b_r = 1. \quad (14)$$

Тут b_r – вагові коефіцієнти, які нормуємо до одиниці; S_r – локальні параметри стійкості, зокрема:

$$\begin{aligned} S_1 &= \frac{AR - AR_{\min}}{AR}; & S_2 &= \frac{C - C_{\min}}{C}; \\ S_3 &= \frac{Q - Q_{\min}}{Q}; & S_4 &= \frac{ACF_{\max} - ACF}{ACF}; \\ S_5 &= \frac{AVM_{\max} - AVM}{AVM}; \\ S_6 &= \frac{AZI_{\max} - AZI}{AZI}. \end{aligned} \quad (15)$$

Тут AR – річний дохід; C – ціна товару; Q – обсяг продаж; ACF – показник загальних матеріальних витрат; AVM – показник прямих матеріальних витрат; AZI – показник величини інвестиційних затрат.

Показник стійкості S проекту пов'язаний із стабілізаційною функцією $\Omega(X_i)$ та її компонентами.

Співвідношення (12)–(14) у комплексі формують оптимізаційну задачу, яка забезпечить стійкість портфеля проектів БП, а також, зокрема, 4-х систем проектів, які є складовими портфеля і орієнтовані на: 1) адаптацію законодавства України до законодавства ЄС, адаптацію технологічного процесу; 2) інтеграцію мереж; 3) уніфікацію нормативно-технічного забезпечення (регламентів та стандартів); 4) модернізацію технічних об'єктів.

ВИСНОВКИ

1. За результатами проведеного дослідження сформульовано інтегральний критерій і оптимізаційну задачу для оцінювання та регулювання ризиків процесів портфеля проектів будівельного підприємства на засадах положень концепції сталого розвитку. Для оптимізації інформаційних та фінансових потоків і покращення системи захисту БП введено функціонал якості з урахуванням оберненого зв'язку, а також стабілізаційної функції.
2. Для забезпечення виробничо-економічної стійкості портфеля проектів і його 4-х складових частин (проектів, орієнтованих на: адаптацію законодавства України до законо-

давства Європейського Союзу, адаптацію технологічного процесу; інтеграцію мереж; уніфікацію нормативно-технічного забезпечення; модернізацію технічних об'єктів) уведено стабілізаційну функцію та інтегральний показник стійкості.

3. Для реалізації інвестиційного проекту доцільно використати оцінку, за якою обчислюємо прибуток, і згідно з нею та критерієм ризикології необхідно визначати ефективність діяльності організації (підприємства). Для формування адекватної до ринкових умов стратегії розвитку інвестиційного проекту (портфеля проектів) на основі вибраного економічно-обґрунтованого оцінювання варто дотримуватись системи моніторингу (далі – СМ) його (проекту) функціонування і для неї (СМ) запропоновано співвідношення оптимізаційної задачі та основні завдання.

4. При розробці стратегії розвитку проектів потрібно приділяти більше уваги прогнозуванню основних економічних показників. Для дослідження закономірностей економічного розвитку проектного комплексу регіонів України доцільно буде в перспективі використати статистичні ряди динаміки, які дозволять одержати характеристику розвитку виробництва за часовим рівнем, оцінити його динаміку за допомогою системи статистичних показників, виявити і кількісно оцінити основну тенденцію розвитку (тренд), вивчити періодичні коливання і, у підсумку, здійснювати прогнозування для прийняття управлінських рішень з урахуванням можливих ризиків.

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Організаційні аспекти фінансового забезпечення агропромислового комплексу: досвід розвинених країн

Organisational Aspects of Financial Support for the Agro-Industry: The Experience of Developed Countries

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Анотація. Мета – дослідження організаційних аспектів фінансового забезпечення агропромислового комплексу розвинених країн та визначення можливостей їх імплементації в Україні. В статті проаналізовано досвід державного та кредитного фінансування агропромислового комплексу розвинених країн (на прикладі Сполучених Штатів Америки, країн Європейського Союзу, Канади та Японії); виділено їх позитивні риси та можливості імплементації цього досвіду для України. Вивчаючи досвід фінансового забезпечення агропромислового комплексу розвинених країн, можна зробити висновок, що в них склалися специфічні системи обслуговування сільськогосподарського виробництва. Це зумовлено, перш за все, особливостями даної сфери економіки, а саме необхідністю усунення явища економічних криз, які виникають з різних причин: циклічність економічного розвитку чи соціально-економічна нестабільність. Державна підтримка іноземного агропромислового комплексу в різних країнах має свої позитивні наслідки. Проте, з різних причин застосувати окремий інструмент державної підтримки в Україні на основі зарубіжного досвіду неможливо. По-перше, в країнах ЄС та інших розвинутих країнах світу аграрний сектор характеризується перевиробництвом сільськогосподарської продукції. З іншого боку, в Україні необхідно нарощувати виробництво вітчизняної сільськогосподарської продукції. По-друге, перш ніж прийняти рішення про посилення державної підтримки агропромислового комплексу, необхідно взяти до уваги рівень дефіциту бюджету, за якого Україна навряд чи зможе вжити певних заходів порівняно з іншими країнами. Окрім цього, варто брати до уваги значні втрати агропромислового комплексу внаслідок воєнних дій на території України та перерозподіл державного бюджету на мінімізацію цих наслідків. Без наявних бюджетних коштів забезпечити належний рівень розвитку аграрного сектора економіки України нереально.

Ключові слова: агропромисловий комплекс; фінансове забезпечення; державна підтримка; кредитування АПК.

Abstract. The research aims to study the organizational aspects of financial support for the agro-industry of developed countries and to determine the possibilities of their implementation in Ukraine. The article analyzes the experience of state and credit financing of the agro-industry of developed countries (using the example of the United States of America, countries of the European Union, Canada and Japan); their positive features and possibilities of implementation of this experience for Ukraine are highlighted. Studying the experience of financial support of the agro-industry of developed countries, we can conclude that they have developed specific systems for servicing agricultural production. This is caused, first of all, by the peculiarities of this sphere of

economy, namely the need to eliminate the phenomenon of economic crises that arise for various reasons: cyclical economic development or socio-economic instability. State support of the foreign agro-industry in multiple countries has positive consequences. However, it is impossible to apply a separate instrument of state support in Ukraine based on foreign experience for various reasons. Firstly, in the EU and other developed countries, the agricultural sector is characterized by the overproduction of farm products. On the other hand, in Ukraine, it is necessary to increase the production of domestic farm products. Secondly, before deciding to increase state support for the agro-industry, it is essential to take into account the level of the budget deficit, for which Ukraine is unlikely to be able to take specific measures compared to other countries. In addition, it is worth taking into account the significant losses of the agro-industrial complex as a result of military operations on the territory of Ukraine and the redistribution of the state budget to minimize these consequences. Without available budget funds, it is impossible to ensure the proper level of development of the agricultural sector of the Ukrainian economy.

Keywords: agro-industry; financial security; state support; agro-industry lending.

ВСТУП

Існуючі в Україні процедури формування та використання організаційно-економічних механізмів фінансового забезпечення агропромислового виробництва є незавершеними та потребують суттєвого вдосконалення. У цьому плані позитивні корективи можна внести, вивчивши досвід іноземної фінансової підтримки у сфері агропромислового комплексу.

Вивченням питань фінансового забезпечення, формування систем фінансової безпеки та інституційного нагляду за процесом фінансування підприємств агропромислового комплексу присвячено праці багатьох вчених, зокрема М. Дудка у [3] проводить діагностику та оцінку зв'язку між формою фінансування та рівнем рентабельності підприємств агропромислового сектору економіки. Вчений С. Захарін у [14] викладає результати досліджень з питань удосконалення механізмів державного регулювання фінансування інвестиційної та інноваційної діяльності в агропромислому комплексі. Автор Н. Левченко у [9] на підставі аналізу досвіду країн ЄС обґрунтовує вагомість бюджетної підтримки розвитку АПК. Фахівець А. Марина у [10] визначає напрямки фінансування агропромислового комплексу України на основі дослідження сучасного стану державної підтримки сільськогосподарських підприємств. Проте багато питань залишаються невирішеними, що відображає необхідність подальших наукових досліджень. Зокрема, заслуговують на увагу питання самофінансування іноземних сільськогосподарських організацій, управлінські

заходи щодо ефективного використання та мобілізації ресурсів, методи залучення коштів, способи державної підтримки.

Метою статті є дослідження організаційних аспектів фінансового забезпечення агропромислового комплексу розвинених країн та визначення можливостей їх імплементації в Україні.

Основними завданнями дослідження є: проаналізувати досвід державного та кредитного фінансування агропромислового комплексу розвинених країн (на прикладі США, країн ЄС, Канади та Японії); виділити їх позитивні риси та можливості імплементації цього досвіду для України.

Основна гіпотеза дослідження полягає у тому, що кращий зарубіжний досвід з питань організації належного фінансового забезпечення аграрного сектору потребує більш детального вивчення з точки зору оцінки можливостей його використання у вітчизняних умовах. Однак просте «копіювання» кращих зарубіжних практик без врахування особливостей сучасних умов функціонування галузі неможливе за сучасних умов функціонування галузі.

РЕЗУЛЬТАТИ ДОСЛІДЖЕННЯ

У високорозвинених країнах світу задля підтримки розвитку агропромислового комплексу держава через уповноважені органи проводить гнучку фіскальну політику, організує преференційне кредитування, бере участь в страхуванні агропромислового комплексу, здійснює підтримку доходів сільськогоспо-

дарських виробників, проводить цінове та тарифне регулювання, виділяє державні інвестиції та використовує інші заходи державної підтримки та регулювання. Саме завдяки посиленій державній підтримці агропромислового комплексу країни – найбільші експортери продовольства – США, Канада, країни Європейського союзу, Китай, Японія – змогли досягти збільшення параметрів агропромислового виробництва та зміцнення своєї продовольчої безпеки.

Найважливішим фактором розвитку агропромислового сектору США є його регулювання та підтримка. Агропромислова політика США умовно поділяється на три основні групи заходів:

- забезпечення основ продовольчої безпеки (заходи грошово-кредитної та податкової політики; регулювання доходів селян; підтримка цін на продукцію; заходи зовнішньоторгівельного регулювання; регулювання ринків збуту; науково-інформаційне забезпечення та обслуговування агропромислового сектору);
- забезпечення населення доступним та повноцінним продовольством (державний контроль якості та оцінка безпеки продовольства; продовольча допомога населенню; запобігання втратам продовольства; сприяння забезпеченню раціонального харчування громадян);
- оптимізація використання природних ресурсів та сільський розвиток (сприяння раціональному природокористуванню, збереження та підвищення родючості ґрунтів; водоохоронні заходи; комплексний розвиток сільських територій).

Специфічною рисою агропромислового комплексу США є те, що провідною організаційно-правовою формою агробізнесу є фермерські господарства. У останні десятиліття склалася тенденція укрупнення і зростання їх концентрації: число фермерських господарств з кінця 1970-х років в США поступово скоротилося приблизно на 30%, а середня площа одного збільшилася з 125 до 220 гектарів. Поступово зростає і концентрація товарного виробництва аграрної продукції: основний обсяг товарної продукції дають 20% фермерів, інші господарства малотоварні чи просто самоспоживаючі [8]. Сильний і процвітаючий сільськогосподарський сектор має важливе значення для добробуту економіки

США. Американські фермери забезпечують надійне постачання продовольства, сприяють зростанню робочих місць і сприяють економічному розвитку.

У системі державної підтримки агропромислового комплексу в США значна частина належить субсидіям підтримки цін. Система цінового регулювання включає встановлення мінімальної та максимальної меж ціни, а також умовної ціни, яку намагається підтримувати держава; державні закупівлі агропромислової продукції для товарної інтервенції та підтримки умовної ціни на продукцію сектору.

Щоб підтримувати конкурентоспроможний сільськогосподарський сектор, Міністерство сільського господарства США підтримує здатність фермерів і власників ранчо розпочинати й підтримувати прибутковий бізнес, а також надає фінансову підтримку виробникам, які постраждали від стихійних лих. Крім того, дослідницькі агенції Міністерства сільського господарства США продовжують запроваджувати високопродуктивні види рослин, тварин та інтегровані варіанти управління, які підвищують ефективність сільськогосподарських методів. Також у системі державної підтримки агропромислового комплексу в США важливою є система страхування. Річна нормалізована вартість захисту від ризиків, що надається сільськогосподарським виробникам через Федеральну програму страхування сільськогосподарських культур наведена на рисунку 1.

Дані рисунку 1 показують, що вартість захисту від ризиків, що надається сільськогосподарським виробникам в США має тенденцію до щорічного зростання та перевиконання планового значення, що має вагомий вплив для розвитку агропромислового комплексу країни.

У США високо розвинена система сільськогосподарського фінансування, яка дозволяє, окрім бюджетних ресурсів та традиційного комерційного банківського кредитування, залучити значні кошти на міжнародних та національних ринках капіталу. Важливе значення у системі заходів державної підтримки агропромислового комплексу в США відведено програмам у сфері кредитування. У США функціонує заснована державою кооперативна кредитна організація сільськогосподарських виробників – фермерська кредитна си-

стема (*FCS*) [8]. Уряд в даному випадку виступає у якості не тільки регулювальника роботи всіх кредитних інститутів, а й як гарант і контролер *FCS*.

Також уряд бере участь у формуванні кредитних ресурсів, які надаються суб'єктам агропромислового сектору. Фінансова мережа *FCS* залучає кошти, продаючи цінні папери інвес-

торам по всьому світу, а потім переводить цей капітал у сільськогосподарський сектор США. Маючи високий рейтинг AAA, боргові зобов'язання *FCS* мають високий попит, що призводить до конкурентоспроможних процентних ставок за кредитами для клієнтів незалежно від фінансових умов у сільськогосподарській галузі.

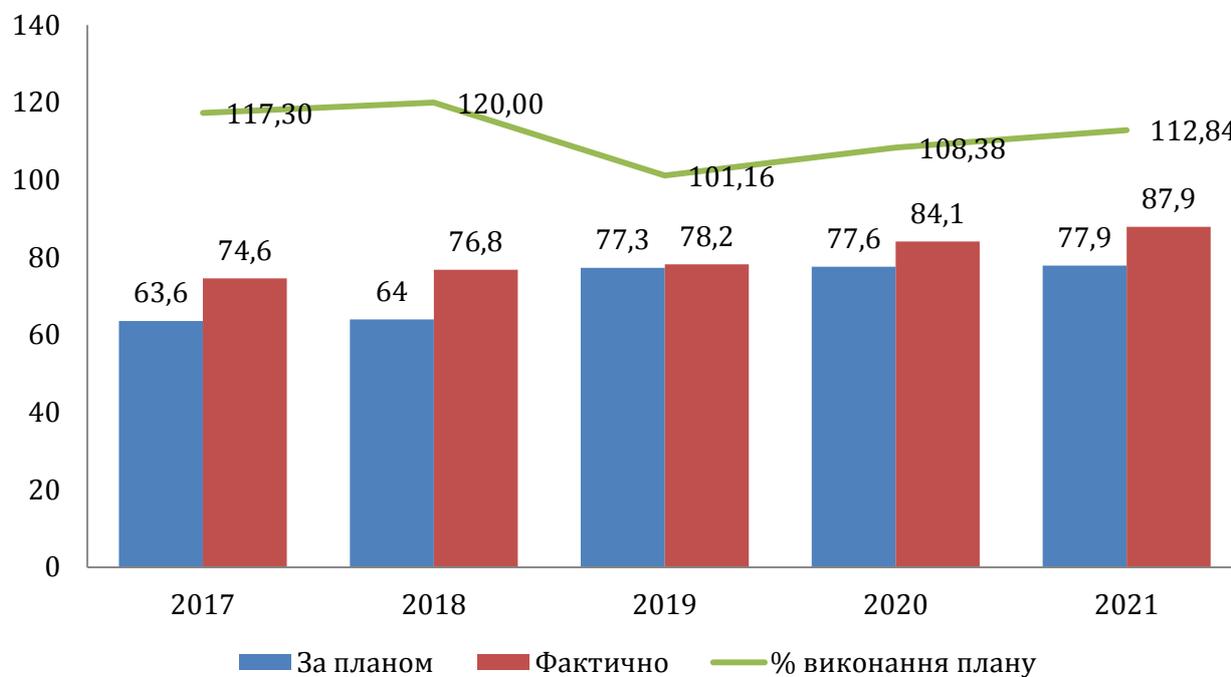


Рисунок 1 – Річна нормалізована вартість захисту від ризиків, що надається сільськогосподарським виробникам через Федеральну програму страхування сільськогосподарських культур за 2017-2021 рр., млрд дол. США [13]

Система *FCS* працює за принципом фінансування через кредитні кооперативи, що належать фермерам та багаторазово підвищує її ефективність, адже клієнти є одночасно власниками фінансового бізнесу та зацікавлені в підвищенні прибутковості та зростанні капіталізації корпорації. Правила роботи фінансових установ встановлюються членами Ради директорів, котрі є клієнтами *FCS* та обираються колегами. Це забезпечує повне розуміння специфіки роботи у сільськогосподарському секторі та встановлення вигідних схем співпраці з підприємцями. Коли асоціації *FCS* процвітають, вони часто повертають частину свого доходу своїм клієнтам-власникам, а ці надходження, в свою чергу, зменшують відсоткову ставку для позичальників. Повернення патронажу є ключовою відмінністю між системою *FCS* та іншими комерційними кредиторами в США: ця система дозволяє створювати нові робочі місця та стимулює

економічне зростання, адже надає кредити як фермерам, так і підприємствам суміжних галузей. Система *FCS* формує можливості для індивідуального підходу до кожного підприємця та умови для підтримки найбільш уразливих категорій. Кредитні установи пропонують досить гнучкі умови фінансування та довгострокові кредити (до прикладу, з можливістю відстрочення платежу та виплатою відсотків щорічно).

Дослідницький інтерес викликає також агропромислова політика країн Європейського союзу. Країни Європейського союзу вирішують проблеми державного регулювання та державної фінансової підтримки агропромислового комплексу як шляхом вироблення заходів на національному рівні, так і шляхом реалізації управлінських рішень у рамках єдиної загальнонаціональної політики Європейського союзу. Бюджет Єдиної агропродовольчої політики формується із двох джерел:

Європейського аграрного фонду гарантування [5] та Європейського аграрного фонду розвитку сільських територій [4]. На продукти першої необхідності заздалегідь встановлюються мінімальні ціни. Для того, щоб зберегти стабільність рівня цін у випадку зниження ринкових більш ніж на 10% нижче за мінімальний рівень, уповноважені органи Європейського союзу організують їх гарантовані закупівлі за заздалегідь встановленими фіксованими цінами. Серед пріоритетів агропродовольчої політики країн Європейського союзу лідирують принципи стимулювання внутрішнього попиту переважно на продукти, вироблені країнами об'єднання. Для обмеження імпорту сільськогосподарської продукції Європейський союз використовує такі методи, як підвищення розмірів ввізного мита, розробка технічних стандартів на продовольчу продукцію, субсидування експорту, встановлення квот та ін. Ці заходи сприяють стабілізації стану та розвитку місцевих товаровиробників.

Кожна країна Європейського союзу виробляє національні програми розвитку агропромислового сектору, оцінюючи та аналізуючи проблеми та потреби підвідомчих територій. Водночас Європейським союзом встановлено спільні пріоритети агропродовольчої політики, яких країни ЄС мають дотримуватись [6]:

- сприяння передачі знань у сільське господарство та сільські регіони кожної країни;
- всебічне підвищення життєздатності та конкурентоспроможності сільського господарства, сприяння впровадженню інноваційних технологій в агропромисловий комплекс;
- формування «продовольчого ланцюжка», організація оптимальних умов для утримання та годування сільськогосподарських тварин;
- управління виробничими, фінансово-економічними та екологічними ризиками у сільському господарстві;
- відновлення, збереження, зміцнення та дбайливе використання екосистем, пов'язаних з агропромисловим виробництвом;
- всебічне сприяння ресурсозбереженню та підтримка переходу до низьковуглецевої та стійкої до кліматичних змін економіці в галузях агропромислового комплексу;

- сприяння соціально-економічному розвитку села, соціальної інтеграції, зменшенню масштабів бідності сільського населення.

Незважаючи на єдині підходи до реалізації агропромислової політики, окремі країни Європейського союзу мають певну свободу ухвалення управлінських рішень, виходячи з конкретних місцевих потреб кожної підвідомчої території. За 2014-2020 роки у країнах Європейського союзу було вироблено та продовжують реалізацію 115 спеціальних програм розвитку сільських регіонів (*Rural Development Programmes* [7]). У тому числі 20 програм є єдиними національними програмами (таблиця 1).

Таблиця 1 – Параметри фінансування програм розвитку сільських територій країн Євросоюзу на 2014–2020 роки [7]

Країна	Число чинних програм	Обсяг фінансування, млн. євро	% від загального обсягу фінансування ЄС
Франція	30	11385	12,09
Італія	23	10444	11,09
Іспанія	19	8297	8,81
Німеччина	15	9446	10,03
Португалія	3	4058	4,31
Бельгія	2	648	0,69
Австрія	2	3938	4,18
Фінляндія	2	2380	2,53
Болгарія	1	2367	2,51
Чехія	1	2306	2,45
Данія	1	919	0,98
Естонія	1	823	0,87
Ірландія	1	2191	2,33
Греція	1	4718	5,01
Хорватія	1	2026	2,15
Кіпр	1	132	0,14
Латвія	1	1076	1,14
Литва	1	1613	1,71
Люксембург	1	101	0,11
Угорщина	1	3431	3,64
Мальта	1	97	0,10
Нідерланди	1	765	0,81
Польща	1	8698	9,24
Румунія	1	8128	8,63
Словенія	1	838	0,89
Словаччина	1	1560	1,66
Швеція	1	1764	1,87
Усього по ЄС	115	94149	100

За кількістю чинних програм у Європейському союзі лідирує Франція (30 програм із часткою фінансування 11,5%). Франція не випадково є найактивнішим учасником розвитку агропромислового комплексу. Проблема опустіння сільської місцевості у Франції серйозно загострилася ще повоєнні роки, під час економічного підйому країни, що став катализатором масової урбанізації французьких провінцій. Це стало приводом для розробки та створення у 1963 році міжвідомчого інструменту відновлення рівноваги між великими містами та провінцією – агенції *DATAR* [11], основними цілями якого було: розвиток виробництва переважно у провінціях (створення «полісів конкурентоспроможності»). З цією метою було розроблено комплексні заходи для створення сприятливих умов для підприємців у сільській місцевості – пільгові режими оподаткування, нова сучасна інфраструктура, субсидування тощо. Завдяки формуванню агенції *DATAR* уряду Франції вдалося впоратися з процесом міграції сільського населення і переламати тенденцію відтоку жителів із села – це дозволило підвищити рівень зайнятості на селі та домогтися диверсифікації сільської економіки, що дозволяє французьким провінціям інтенсивно розвиватися до цих пір. У 2009 році *DATAR* передав свої місії Генеральній комісії з питань територіальної рівності [2]. Саме комплексний підхід, котрий враховує всі аспекти життєдіяльності агропромислового комплексу Франції зміг забезпечити повноцінне, ефективне вирішення проблем розвитку аграрного сектору та досягти збалансування системи продовольчого забезпечення.

Наступною за кількістю чинних програм у Європейському союзі є Італія (23 програми з часткою 10,5%). В Італії основним елементом підтримки сільськогосподарських товаровиробників виступає система кредитної кооперації. Кредитування аграрного сектора через систему кооперативних банків також поширене у Франції, Німеччині, Польщі. На частку кооперативних банків припадає у Франції 75% сільськогосподарського кредиту, в Італії – 60%, в Німеччині – 44%, Банки такого типу надають усі види позичок різної терміновості. Системи кредитування аграрного виробництва, що склалися за кордоном, в кожній країні відрізняються своїми підходами до підтримки агропромислового комплексу. Можна відзначити й загальні тенденції: активну участь

держави у формуванні системи кредитування агропромислового комплексу; нормативно-правове забезпечення умов функціонування кредитної системи; фінансово-кредитна підтримка агропромислового комплексу.

Розглянемо також досвід Німеччини (15 програм із часткою 9,5%). Сучасну систему агропромислового кредитування Німеччини у всьому світі визнано класичною. Держава активно реалізує пільгову політику щодо сільськогосподарських товаровиробників. В основному підтримуються фермери до 40 років – їм надається пільгове кредитування з метою здійснення капітальних вкладень у виробничу інфраструктуру, будівництво житла, купівлю орендованого господарства. В Німеччині функціонує Німецький Союз кооперативів (*The German Cooperative and Raiffeisen Confederation*) [12], яким об'єднані всі кредитні (кредитно-споживчі) кооперативи країни – у тому числі й зайняті у сфері сільськогосподарського кредитування. Згідно з німецьким законодавством, кредитна кооперація зосереджена у вигляді своєрідної ієрархії, що складається із трьох рівнів: «базовою» ланкою аграрного кредитування виступають об'єднуючі виробників, місцеві кооперативи, які здійснюють свою діяльність у межах окремого муніципалітету; такі кооперативи об'єднані в регіональні сільськогосподарські банки, які «зливаються» у результаті єдиний кооперативний банк. Інформація про діяльність сільськогосподарської кредитної кооперації в Німеччині повністю прозора, а відомості про кредитування суб'єктів агропромислового комплексу розміщені у вільному доступі на веб-сайті федерального міністерства сільського господарства.

Дещо відмінною від країн Європейського Союзу та США щодо регулювання фінансового забезпечення агропромислового комплексу є політика Канади. Традиційно, на відміну від США та Європейського Союзу, канадська урядова система преференцій для агропромислового комплексу базується не на прямій підтримці прибутковості галузі, а на заходах, що допомагають фермерським господарствам отримувати стабільний середній дохід від реалізації продукції. Україна має певний інтерес до напряму фінансування, економічного змісту та механізму реалізації окремих проектів, адже вона ще не завершила процес системного впровадження всіх доступних державних

інструментів регулювання в аграрному секторі.

Для України повчальним у царині державної підтримки агропромислового комплексу є досвід Японії. Аналіз державної підтримки сільськогосподарського виробництва в цій країні показує, що майже 80% обсягів сільськогосподарського виробництва є предметом державних програм і заходів, зокрема [1]:

- закупівельна ціна рису встановлюється в розмірі, необхідному для забезпечення відшкодування витрат на його виробництво;
- на окремі види сільськогосподарської продукції встановлюються граничні ціни, але якщо вони не відповідають ринковим цінам, держава гарантує закупівлю такої сільськогосподарської продукції;
- держава забезпечує виробникам мінімальний рівень цін або компенсує різницю між регульованою ціною та ефективною ціною продажу при зниженні ціни;

– створено адекватну підтримку сільськогосподарської науки та сільськогосподарської інженерії.

Тим часом, пільгові кредити приватному сектору також широко використовуються в Японії. Це дає можливість контролювати цільове використання кредитів на державному рівні. Як наслідок, тільки за останні роки пільгове кредитування агропромислового сектору зросло майже на 50%, що призвело до зростання виробництва. У Японії ключовим фінансово-кредитним інститутом є Центральний кооперативний банк. Кооперативні кредити найчастіше мають короткостроковий характер, а довгострокове кредитування забезпечується урядовими програмами через державну корпорацію фінансування сільського, лісового та рибного господарства.

Основні показники, що характеризують рівень державної підтримки агропромислового комплексу, наведено нижче. На рисунку 2 показано структуру прямих субсидій сектору в досліджуваних країнах.

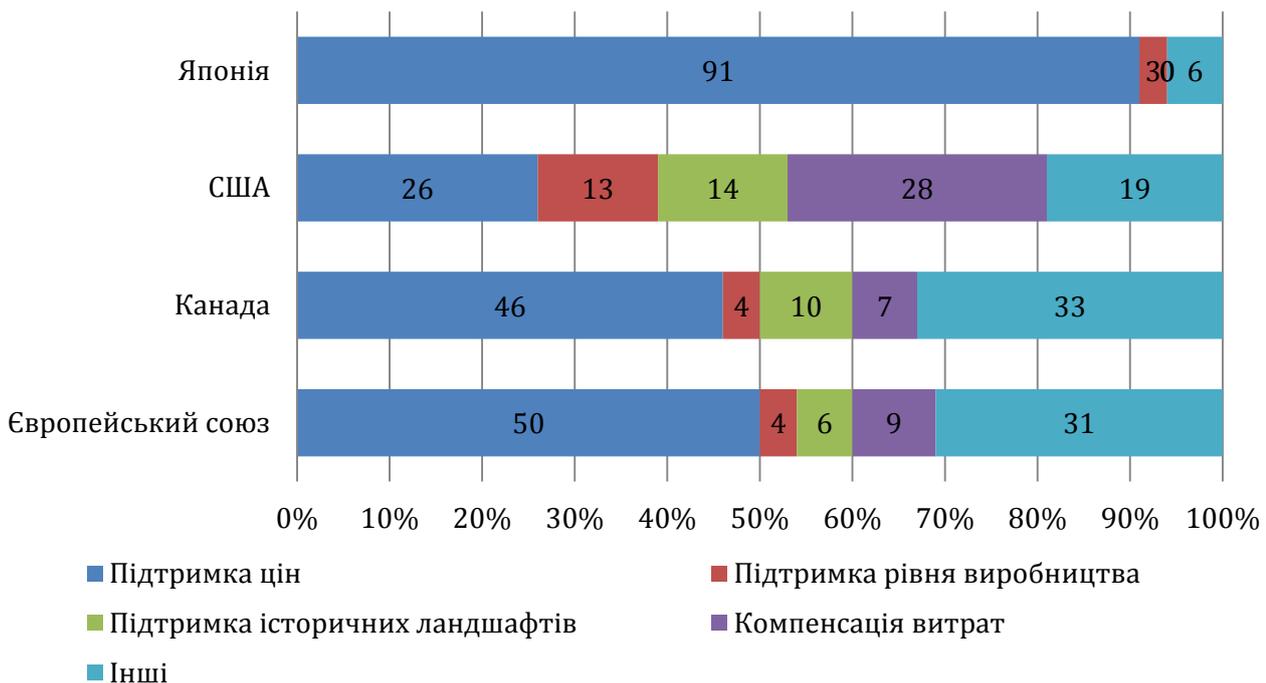


Рисунок 2– Структура прямих субсидій на підтримку агропромислового комплексу у розвинених країнах, % [8, 7]

Дані рисунку 2 показують, що 91% прямих субсидій у Японії йде підтримку цін, по 3 % підтримку рівня виробництва та компенсацію витрат, у США 26% – підтримку цін, 13% – підтримку рівня виробництва, 14% – на підтримку історичних ландшафтів, 28% – на ком-

пенсацію витрат. Близько 50% цих субсидій на підтримку цін спрямовують в ЄС та Канаді.

Структура непрямих витрат за країнами наведена на рисунку 3.

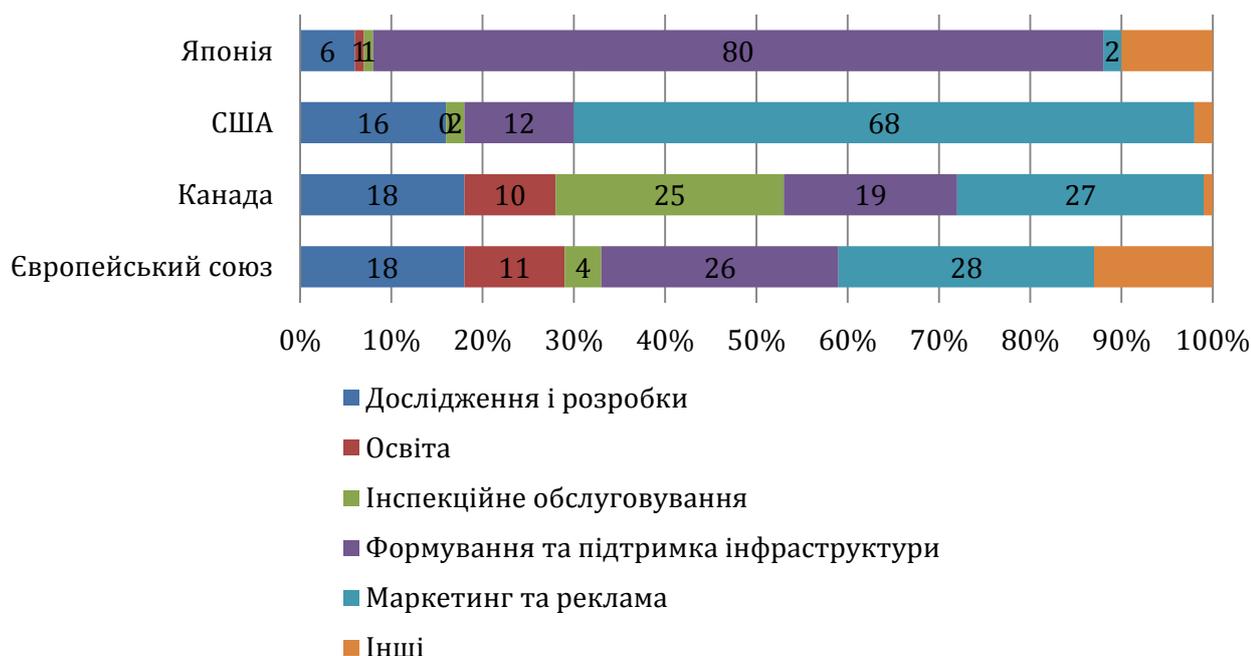


Рисунок 3– Структура непрямих витрат на підтримку агропромислового комплексу у розвинених країнах, % [8, 7]

Дані рисунку 3 показують, що у структурі непрямих витрат також немає однакової спрямованості за статтями. Так, наприклад, 80% непрямих витрат у Японії виділяється на формування та підтримку інфраструктури. У США 68% витрачають на маркетинг та рекламу, 16% на дослідження та розробки та 12% на формування та підтримку інфраструктури. Це вказує на різні підходи до фінансування агропромислового комплексу у різних країнах.

Зарубіжний досвід засвідчує, що держава напряму підтримує прибутковість підприємств агропромислового шляхом цінового регулювання та квотування виробництва, а також обмежує рівень ринкових цін монополій шляхом запровадження жорсткого антимонопольного законодавства та іншими засобами. Іншими словами, ринкова анархія в цьому відношенні недопустима ні в США, ні в країнах ЄС, ні в Японії: існує чіткий економічний механізм оптимізації дій ринку і національних регуляторів.

ВИСНОВКИ

Вивчаючи досвід фінансового забезпечення агропромислового комплексу розвинених країн, можна зробити висновок, що в них склалися специфічні системи обслуговування сільськогосподарського виробництва. Це зу-

мовлено, перш за все, особливостями даної сфери економіки, а саме необхідністю усунення явища економічних криз, які виникають з різних причин: циклічність економічного розвитку чи соціально-економічна нестабільність. Державна підтримка іноземного агропромислового комплексу в різних країнах має свої позитивні наслідки.

В Україні державна підтримка сільськогосподарського виробництва включає численні програми, зокрема: фінансування наукових розробок, фундаментальних і прикладних досліджень; фінансова підтримка агробізнесу через механізми здешевлення кредитів; підтримка рослинництва, тваринництва, птахівництва та рибництва. Проте, з різних причин застосувати окремий інструмент державної підтримки в Україні на основі зарубіжного досвіду неможливо. По-перше, в країнах ЄС та інших розвинутих країнах світу аграрний сектор характеризується перевиробництвом сільськогосподарської продукції, з іншого боку, в Україні необхідно нарощувати виробництво вітчизняної сільськогосподарської продукції. По-друге, перш ніж прийняти рішення про посилення державної підтримки агропромислового комплексу, необхідно взяти до уваги рівень дефіциту бюджету, за якого Україна навряд чи зможе вжити певних заходів порівняно з іншими країнами. Окрім цього, варто брати до уваги значні втрати агроп-

ромислового комплексу внаслідок воєнних дій на території України та перерозподіл державного бюджету на мінімізацію цих наслідків. Без наявних бюджетних коштів забезпечити належний рівень розвитку аграрного сектора економіки України нереально.

Перспективами подальших досліджень у цьому напрямку вбачаємо глибинне дослідження кредитного забезпечення агропромислового комплексу в розвинених країнах та Україні.

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The Effect of Health Consciousness, Food Safety Concern, and Familiarity with Advertisements on Willingness to Pay to Purchase Healthy Food Products

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Abstract. This study aims to determine the influence of health consciousness, food safety concern, and familiarity in advertising on the willingness to pay for the purchase of healthy food products, namely Lemonilo in West Nusa Tenggara. The type of research used is quantitative research with a causality association approach. This study's respondents are consumers who have never bought Lemonilo products in West Nusa Tenggara. The number of samples taken was 120 consumers aged 20-50 years. The sampling technique used was the purposive sampling technique. The data analysis used in this study was multiple linear regression analysis with SPSS 2.6 for windows applications. The results showed that health consciousness and food safety concern does not affect willingness to pay. Meanwhile, familiarity with the advertisement significantly affects willingness to pay.

Keywords: health consciousness; food safety concern; familiarity in advertisement; willingness to pay.

INTRODUCTION

In the current era of globalisation, global competition is getting more demanding in all aspects. Factors that can support the quality of human resources are essential to consider competing. One of the factors that can help the performance of human resources in the era of globalisation is health. Today, more and more people are starting to realise and change their habits by paying attention to their lifestyles, such as healthy food consumption patterns to overcome health problems. At this time in Indonesia, the demand for organic products is quite significant. However, organic food marketing in Indonesia is still constrained by the perception of the price of organic food, which is considered expensive. For this reason, companies need to determine a suitable marketing strategy so that consumers are willing to pay for healthy food products. According to [7], willingness to pay is the highest price a consumer is willing to pay to get a benefit in the form of goods or services.

In general, some people consider organic food an expensive product, but for those who adopt a

healthy lifestyle, this is not uncommon, and they are still willing to pay more for the food they want to consume. Nearly 64% of consumers in the world say that they are willing to pay more for food or drinks that contain the desired ingredients according to their health concerns [22].

The World Instant Noodles Association shows that Indonesia ranks second with the highest global demand for noodles. Seeing the high demand for instant noodles in Indonesia, producers that create instant noodle products that use organic ingredients have emerged. They make products that are safer to consume regularly, one of which is instant noodles launched by Lemonilo, which are made from organic ingredients and various selected spices. Since its launch in September 2017, Lemonilo has received quite a positive response. The advantages of Lemonilo and how Lemonilo consumers feel about the products have undoubtedly created a willingness to pay for their product.

Companies increase consumers' willingness to pay for the products offered by paying attention to the health consciousness factor, which is a concern to become better and motivated to im-

prove, maintain, and maintain health and quality of life by implementing a healthy lifestyle. On the other hand, the increasingly fierce competition in the food industry can open up the possibility for companies to carry out unethical behaviour, for example, by using chemicals in producing these foods. Therefore, attention to food safety (food safety concern) by consuming organic food can be used as an alternative to reduce the risk of these health problems.

This research stems from the inconsistency of the results of previous studies. For example, research conducted by [1, 18] shows that the health consciousness variable significantly affects willingness to pay in consumers' willingness to pay for organic products. But a different opinion was expressed by [2], where the results of his research show that women aged 17 years and over who routinely use cosmetics and are considering buying green cosmetics show that the health consciousness variable has no significant effect on willingness to pay.

In addition, research on the effect of a food safety concern on willingness to pay also shows inconsistent results. Research conducted by [3] shows that food safety concerns have a significant impact on willingness to pay for purchasing organic rice products. On the other hand, a different result was found by [4], who stated that food quality and food safety have the same impact on willingness to pay, indicating an inevitable confusion about their significance. In terms of familiarity, some studies showed varied results. For example, [5] research shows that most consumers are willing to pay more because they know the benefits or are familiar with these organic products. On the other hand, [6] stated in his research that familiarity with advertisements for purchasing food supplement products does not significantly affect willingness to pay.

With the inconsistency of previous studies' results, this research topic becomes interesting to study. In addition, there are still not many studies that specifically discuss willingness to pay for organic instant noodle products, so further research is sorely needed. In particular, this study will analyse the effect of health consciousness, food safety concern, and familiarity in advertisements on willingness to pay.

Literature review

Willingness to Pay. Willingness to pay is an economic value defined as a measurement of the maximum number of people's willingness to sacrifice goods and services to obtain other goods and services. The concept of a person's willingness to pay for goods or services produced by natural resources and the environment is formally referred to as willingness to pay [6]. Additionally, the author [7] explains the willingness to deliver the highest price given by the company to prospective consumers to get products that can provide a benefit and become a reference for how many potential consumers value the product.

The Effect of Health Consciousness on Willingness to Pay. Authors [8] stated that health awareness is oriented towards a healthy lifestyle. The author [9] re-conceptualises the dimensions that previous researchers have made and finds three dimensions in health consciousness, namely:

- (1) Self-health awareness, the tendency to focus attention on healthy behaviours such as activities, interests, and health-oriented opinions;
- (2) Personal responsibility, people who are aware of health feel more responsible for maintaining health and tend not only to engage in preventive behaviour and maintain health in daily life but also actively participate in the health community;
- (3) Health motivation indicates an individual's intrinsic motivation to maintain good health and its reflection or responsibility for health.

According to [36], the most frequent motive for buying organic food is consumers' perception that organic food is healthier for consumption. Consumers of organic foods may be more aware that the amount of food they consume can affect their health. They value health and pay more attention to choosing natural and healthy foods to maintain and improve their health. After the consumers know that organic food is healthy, the tendency to buy organic food is even greater. Therefore, this study proposes the first hypothesis as follows: H₁: Health consciousness affects willingness to pay for the purchase of Lemonilo healthy food products.

The Effect of Food Safety Concerns on Willingness to Pay. According to [37], food safety is defined as the freedom of food from substances or materials that can harm the body without distinguishing whether the meaning is naturally present in the ingredients used or mixed intentionally or unin-

tentionally into food ingredients finished food. On the other hand, [38] defines food safety as a condition and effort to maintain food quality to prevent contamination or foodborne disease.

Authors [39] define food safety as a consumer concern with food produced from chemical sprays, fertilisers, and preservatives. Consumers are generally willing to pay or buy a product that increases food safety concerns, so it is said that food safety concerns can influence consumers before making a purchase decision. Authors [40] support this statement by stating in their research that food safety concerns have become a motivating factor for consumers to seek safer food and guaranteed quality or attributes. Therefore, the second hypothesis proposed in this study is H₂: Food safety concerns affect willingness to pay for purchases of Lemonilo healthy food products.

The Effect of Familiarity in Advertisement on Willingness to Pay. Authors [21] define familiarity as how much the brand relates directly and indirectly to the experiences that consumers have. Consumers can obtain an indirect brand experience by reading advertisements, the brand's exposure, knowing from other people, and directly buying products. Consumers tend to buy if they are already familiar with a brand. Authors [40] reveal the function of familiarity in identifying the quality of an item or service. Besides, the brand can increase the level of buyer efficiency. The brand makes it easier for consumers to search for goods or services.

Research by [22] states that forming brand awareness can be done instantly or in a relatively short time by using intense, unique and sensational advertising and attractive prizes in stores. A known brand can increase positive familiarity and the possibility of being included in the list of brands to buy. If consumers perceive them as a good quality brand, it will be easier for them to pay more for the brand. So it can be concluded that familiarity is the closeness between the consumer and the brand and product to be purchased. Based on this explanation, the third hypothesis proposed in this study is H₃: Familiarity in Advertisement affects willingness to pay on purchases of Lemonilo healthy food products.

Conceptual Framework. The research concept framework is a concept in the form of a systematically arranged chart, used to provide a brief view of the object of research so that from this research model, the direction and purpose of the

research to be carried out will be known. The conceptual framework of this research is as follows.

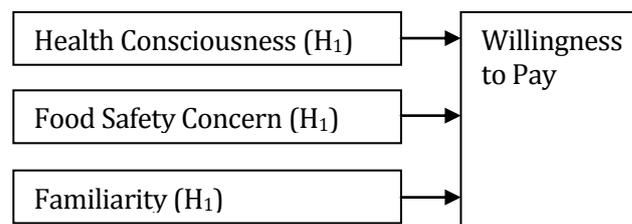


Figure 1 – Conceptual Framework

METHODS

Data collection is done by utilising the online Google form questionnaire application. Respondents come from various demographics (in terms of gender, origin, age, occupation and monthly income). The sampling technique used is purposive sampling, and then questionnaires are distributed to 120 respondents who are Lemonillo consumers aged between 20-50 years. Measurement of variable indicators adopted from previous research, namely health awareness from [12], food safety concern from [13], familiarity with an advertisement from [14] and willingness to pay from [15]. All items were evaluated using a five-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree).

Validity and reliability tests were performed using IBM SPSS version 26 before examining the entire model. A variable is said to be valid and reliable if it gives Cronbach's alpha value ≥ 0.60 [10, 11]. Data analysis in this study used multiple linear regression. Regression analysis is a statistical technique that analyses the linear relationship between two variables by estimating the coefficients for a straight line equation, one variable is expressed as the dependent variable, and the other variable is expressed as the independent variable [13].

This study collected responses from 120 respondents. Because it uses an online questionnaire form, all questions can be set to be mandatory so that respondents would answer all the questions asked. The characteristics of respondents are very varied. One hundred thirty-eight males and 82 females, most of whom (86.7%) were aged between 20 and 30 years. The most dominant occupation of respondents is a private employee (41.7%), while 63 of the respondents

fall into the category whose monthly income is Rp ≤ 2 mln. Complete data can be seen in the following table.

Table 1 – Characteristics of Respondents

Variable	Description	Number	%
Gender	Male	38	31.7
	Female	82	68.3
Age	20-30 years	104	86.7
	30-40 years	10	8.3
	40-50 years	5	4.2
	>50 years	1	0.8
Address	Mataram	41	34.2
	West Lombok	32	26.7
	Central Lombok	21	17.5
	North Lombok	9	7.5
	Sumbawa	7	5.8
	Bima	6	5
	Dompu	4	3.3
Occupation	Private Employee	50	12.5
	College Student	24	20
	Entrepreneur	31	25.8
	Civil Servant	15	12.5
Monthly Income	≤ Rp 2 mln	63	52.5
	Rp 2-5 mln	39	32.5
	Rp 5-10 mln	14	11.6
	Rp 10-15 mln	2	1.7
	≥ Rp 15 mln	2	1.7

RESULTS AND DISCUSSION

The Cronbach Alpha value was used; the results are shown in Table 2 below. According to [10, 11], reliability testing is a tool used to measure a questionnaire which is an indicator of a variable or constructs. The variable is said to be valid and

reliable if it gives Cronbach's alpha value ≥ 0.60 . Based on the following table, the questionnaire in this study is said to be reliable. In addition, it can also be seen from the table that, on average, food safety concern is the priority for consumers.

Table 2 – Reliability Test Result

Variable	Mean	Cronbach's Alpha
Health Consciousness (8 items)	4.21	0.871
Food Safety Concern (7 items)	4.22	0.841
Familiarity in advertisement (5 items)	3.55	0.850
Willingness to Pay (4 items)	3.88	0.691

In terms of the scales' validity, it was evaluated by item-total correlation analyses. The result is displayed in Table 2, where all item-total correlation coefficients surpassed the critical value of r table 0.361 and were statistically significant at $p \leq 0.01$. The scales were therefore reliable and valid. Moreover, the examination of the variance inflation factor (VIF) indicated that multicollinearity was not a problem in the data as they were within tolerable limit; i.e. tolerance values were between 1.076 to 2.319, which were < 10 [13]. Therefore, the authors are confident in the regression results.

Table 3 – Summary of Item-total correlation

Variable	Statement	Item	Item Total Correlations
Health Consciousness	I am alert to any changes in my health	X1.1	0.653
	I think a lot about my health	X1.2	0.754
	I am self-conscious about my health	X1.3	0.619
	I care about my health	X1.4	0.754
	I check my health regularly	X1.5	0.725
	I am very involved with my health	X1.6	0.793
	I am aware of the state of my physical health as I go about the day	X1.7	0.751
	I pay attention to my physical health as I go about the day	X1.8	0.771
Food Safety Concern	I am apprehensive about the safety of my food	X2.1	0.842
	I'm worried that there are harmful chemicals in the food I usually eat	X2.2	0.608
	I pay attention to the safety of the food products	X2.3	0.828

Variable	Statement	Item	Item Total Correlations
	I consume		
	I am concerned about the current danger of the disease and try to take action to prevent it	X2.4	0.570
	I sacrificed a lot for my health	X2.5	0.746
	I think it's essential to know well how to eat healthily	X2.6	0.806
	I know the content of organic food	X2.7	0.674
Familiarity in Advertisement	I know about the Lemonilo brand	X3.1	0.707
	I have various knowledge about the taste of Lemonilo noodles	X3.2	0.906
	When buying noodles, I compare them with brands I have never known	X3.3	0.758
	I love the Lemonilo brand, so it's tough for me to switch to another noodle brand	X3.4	0.834
	Lemonilo products use quality ingredients	X3.5	0.787
Willingness to Pay	I am willing to pay more to get healthier products to consume	Y.1	0.820
	The price of Lemonilo products is by the quality	Y.2	0.781
	I think that products labelled organic are better for consumption	Y.3	0.660
	Lemonilo noodles taste delicious	Y.4	0.673

Notes: *Correlation is significant at the 0.01 level (2-tailed)

For analysis and hypothesis testing, the authors used regression analysis using SPSS 26. As a result, a regression model was developed and displayed in table 4. Table 4 shows that Health consciousness and food safety concerns do not affect the willingness to pay. On the other hand, the data indicate that familiarity with advertisements significantly affects willingness to pay.

Table 4 – Regression Analysis on the Effect of Health Consciousness, Food Safety Concern, and Familiarity in Advertisement on the Willingness to Pay

Variable	β	t count	Sig	Conclusion
Health Consciousness	0.129	1.322	0.189	H ₁ (not supported)
Food Safety Concern	0.059	0.597	0.552	H ₂ (not supported)
Familiarity in Advertisement	0.658	9.867	0.000	H ₃ (supported)
F = 42.029; p = .000; R = .722; adjusted R ² = .508; Std error of the estimate = 1.58146				

Based on the information above, it can be seen that the value of the coefficient of determination

or adjusted R² is 0.508. This means that the willingness to pay variable is simultaneously influenced by the Health Consciousness, Food Safety concerns, and Familiarity with Advertisement variables by 50.8%. The remaining 49.2% is influenced by other variables not discussed in this study. In addition, it is obtained that the f count is greater than the f table (f count 42.029 > f table 3.13 with a p significance value of 0.000, which is smaller than 0.05 so that it is said that the research model with variables X₁ (Health Consciousness), X₂ (Food Safety Concern) and X₃ (Food Safety Concern) can or is feasible to use to predict willingness to pay (Y).

The Effect of Health Consciousness on Willingness to Pay. The research data shows that the t-count value of the health consciousness variable is 1.322 (smaller than t-table 1.980 with a significance of 0.189 (greater than 0.05). This result means that the health consciousness variable does not affect willingness to pay. This can also mean that in this case of Lemonilo healthy food products, although the health consciousness variable increase, it will have no significant effect on consumers' willingness to pay. The results of this study support the results of previous research conducted by [2], which showed that health consciousness did not affect purchasing green cos-

metics. The dominant indicator of health consciousness is health alertness, namely the level of individual awareness of their physical health condition. However, this is not a factor that can affect consumers' willingness to pay more for healthy food products.

The Effect of Food Safety Concerns on Willingness to Pay. Based on the results of research conducted, food safety concerns do not affect willingness to pay. This is indicated by the t value of the food safety concern variable, which is 0.597 (smaller than t table 1,980 with a significance of 0.552 (greater than 0.05). This means that although the food safety concern variable increases, it does not affect the willingness of consumers to pay for healthy food products. The results of this study support the results of previous research conducted by [18], which shows that food safety concerns do not affect consumers' willingness to pay more. The most dominant indicator of food safety concern variables in this study is the knowledge indicator, where consumers assume it is essential to know how healthy the food is. But this is not a factor that can affect consumers' willingness to pay for healthy food products. This is explained by [19, 20, 21]. Consumers' willingness to pay is influenced by different factors such as age, number of family members, personal consumer concerns, family spending, and consumer trust in a product.

The Effect of Familiarity in Advertisement on Willingness to Pay. Based on the research results, it is known that the t value for the familiarity in the advertisement variable is 9.867 (larger than t table 1.980 with a significance of 0.000 (less than 0.05). Thus, it is concluded that familiarity with advertisements significantly affects willingness to pay. It is one of the many factors that can consider by consumers in buying or consuming a product. This means that familiarity in advertising is the closeness between consumers and the brand and the effect they will buy. If Lemonilo advertises heavily, it will increase the willingness of consumers to pay more for these healthy food products. Products that the consumers know can increase positive familiarity and the possibility of being included in the list of products to be purchased by consumers.

This study's results align with the respondents' answers to the five statements of familiarity in advertising. This indicates that in the willingness to pay more for healthy food products, consum-

ers need to know or be familiar with the brand. In addition to consumers knowing that the ingredients used in nutritional food products are high quality, consumers will find it easier to pay for them. The results of this study support the results of previous research conducted by [22], showing that consumers' willingness to pay more for organic vegetables indicates that most consumers are willing to pay more because they know the benefits or are familiar with these organic products.

CONCLUSIONS

This study provides empirical evidence on whether there is an influence between health consciousness, food safety concern and familiarity in advertisements on willingness to pay. The results show that health consciousness does not affect willingness to pay. This is in line with the findings of [2] that health consciousness has no significant effect on purchasing green cosmetics. Food safety concern has no significant impact on willingness to pay either. This is in line with [23] research. On the other hand, familiarity with the advertisement significantly affects willingness to pay. This strengthens the research conducted by [24] that most consumers are willing to pay more because they know or are familiar with organic carrot vegetable products.

This research has managerial implications for the Lemonilo company, namely that the company must pay attention to the reputation built to survive. Furthermore, companies can be directly involved in educating consumers to be more aware of their health and provide information on the importance of health awareness. In addition, Lemonilo, as a healthy lifestyle brand, can provide information and educate consumers about the ingredients in Lemonilo products so that consumers have more confidence in buying and consuming these Lemonilo products.

The limitations of this study are that the research object is only focused on healthy food products from the Lemonilo brand, which is only one of many healthy foods available and that the scope of the research is only in the West Nusa Tenggara area. Further research can be conducted with more comprehensive area coverage. Future researchers can also add other variables to the research model to enrich the findings.

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The Effect of Financial Literacy, Herding Behaviour and Overconfidence on Investment Decisions in the Millennial Generation

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Abstract. This study aims to examine and analyze the influence of financial literacy, herding behaviour, and overconfidence on the investment decisions of the millennial generation in Mataram. A total of 100 millennial investors in Mataram City became respondents in this study. Structural Equation Modeling using intelligent PLS software was used in this study to analyze the data. The study's results prove that financial literacy and overconfidence have a positive and significant effect on the investment decisions of the millennial generation.

In contrast, herding behaviour does not have a positive and considerable influence on the investment decisions of the millennial generation. The results of this study indicate that in addition to investors having good financial literacy, investors can also behave biased in capturing investment decisions, such as being too confident in their information. Excessive trust in investors can make investors wrong in analyzing, impacting lousy investment decisions.

Keywords: investment decisions; financial literacy; herding behaviour; overconfidence.

INTRODUCTION

In line with the current economic growth, the stock market has become the most effective means of encouraging national economic development and building infrastructure [11]. The capital market is the best way to increase economic growth and national development. Many people are starting to understand the value of investing. Investing in stocks offers a significant return on investment [14]. The increase in the number of individual investors (Single Investor Identification) encourages the development of the derivatives market in December 2021 by 7,489,337 investors. The number of individual investors is believed to increase yearly from 2017 to 2021 based on Indonesian Central Securities Depository (KSEI) data. The increase in SID numbers from 2020 to 2021 is around 3,608,584, or about 93% from 3,880,753 to 7,489,337.

In addition, according to the latest investor demographic data in Indonesia, Java is the island with the highest concentration of investors at 69.83%, while Bali, NTB and NTT are growing

much slower, at 3.33% in 2021. According to data KSEI, the capital market in Indonesia is dominated by the millennial generation, which was around 60.02% of the total 7,489,337 investors. This shows the importance of investing in the millennial generation, an age that has developed computers and the internet and can be easier to learn related to finance and apply it to life. This shows that the millennial generation has great potential to invest in the capital market.

Currently, the millennial generation is the generation that dominates the population in various regions. The millennial generation in Mataram has massive information technology capabilities, making accessing everything they need easier. The millennial generation has great potential to invest in the capital market [15]. With increasing investment activity, the success or failure of an investor is determined by whether or not the investor's investment decisions are right, both in determining the type of investment and the time to invest [16]. Investing in one or more assets in the hope of earning a profit in the future is known as an investment decision. A tiered tempo

causes investment decisions to be considered carefully because they have a long-term impact. But along with developments, in making decisions, not all investors behave rationally, but behavioural factors within investors influence investors in making investment decisions [17].

Millennials typically exhibit discriminatory behaviour that is emotionally erratic and uncontrollable, thus making quick decisions about investing. Decisions are based on human emotions, traits, preferences, and involvement which are part of intelligence and social existence. In addition, overconfidence and herd characteristics (following behaviours) can be explained by behavioural finance theory. Millennial investors often make decisions that are not based on correct financial theory, which can lead to cognitive bias. Cognitive bias is a mental process not supported by solid reasoning and not based on rational considerations, so there are deviations and errors of judgment, which are irrational behaviour.

Investors with a rational mindset often take the time and carefully consider their investment options to reduce the losses. According to the theory of planned behaviour, an investor's attitude will impact whether or not they are interested in making the desired decision. The knowledge of finances owned by an investor will affect the results of his investment decisions when deciding to start investing. Investors who are less rational or irrational often make choices influenced by psychology or behaviour based on their emotions or feelings, resulting in poor choices. This irrational mindset can lead to biased decisions in stock transactions [19]. Bias in financial behaviour is explained by overconfidence theory and economic dissonance bias theory (cognitive dissonance theory) in behavioural finance theory.

Among the aspects that can impact investors' requirements to invest are financial literacy and cognitive bias, namely herding behaviour and overconfidence. Financial literacy is defined as an understanding of financial concepts by an investor, which allows investors to have the ability to make sound investment decisions and the confidence to manage personal finances so that, in the end, investors can make healthy investments decision. When an investor decides to submit a decision, he must have a strong understanding of finance (financial literacy) so that the decision has a clear direction that can be used as a motivator for investors when making investment decisions.

When investors make investment decisions, investors can be influenced by herding behaviour. This behaviour is the behaviour when investors around them impact investors. Other investors' decisions easily influence someone with herding behaviour, which can affect the investment decision-making [7]. Herding behaviour is only done by investors because there is no clear information that creates an intention to track the behaviour of other investors who have been there first. Herding behaviour is a biased personality that follows the steps of other shareholders in making investment decisions [16].

The level of investor confidence when it has been successful with the investments made will continue to increase to make other investments in the future. This self-confidence is called overconfidence [24]. This overconfidence behaviour will be seen in investors who overestimate their skills when evaluating a company's capacity as an investment destination [15].

Previous studies that tested different factors and found varying results examined the determinants of investment decisions. Research [8] shows that financial literacy impacts investment decisions, contrary to analysis [22], which shows that the financial literacy of investors cannot be the cause of whether or not an investor is right in determining reasonable and correct decisions. Research [1] reveals that herding behaviour affects investment decisions; conversely, with research [16], herding behaviour does not influence investment decision variables. Study [19] found that overconfidence behaviour affects investment decisions,

Many previous studies, including articles related to this research topic, were used as references during research development. Study [2] investigated the effect of financial literacy on capital market investment decisions. This analysis establishes that investment decisions influence literacy. Students who have a strong understanding of investing and finance should have a strong interest in investing because they understand the choices they will make. This financial literacy debate is one aspect that does not only emphasize investment skills and awareness. Factors that can influence economic decisions about when to invest are taking into account the risks and minimum capital requirements and is one of the

The influence of psychological factors on the investment decisions of young investors in Ambon City shows the act of following other investors

and relying more on group knowledge than individual information; a study conducted by [15]. Assuming this reaction can simplify investors to get an accurate explanation, more investors are also being watched. Shareholders who have encountered deficits in the past may exhibit herding behaviour in making decisions by choosing to emulate other investors. Following in the footsteps of other investors is the impact of the doubt when selecting stocks to invest in.

The research [4] surveyed gold customers in Hungary; this study looks at the impact of overconfidence behaviour on investment decisions. Study findings reveal overconfidence has a beneficial effect on investment choices. According to respondents' responses, they are confident in their financial decisions and highly confident in their knowledge and skills in the investment field. Research that explains cognitive aspects such as self-confidence results in a lack of investor sensitivity and accurate understanding of information, supported by discussions about the impact of overconfidence on financial decisions. Overconfident investors believe they can exploit their knowledge or information to their advantage, but this is entirely delusional.

It is essential to re-examine the effect of the variable financial literacy, herding behaviour, and overconfidence in investment decisions. As previously mentioned, investors in West Nusa Tenggara occupy a low position along with Bali and NTT, with a percentage of 3.33%, so this research wants to find out the attitude or behaviour of millennial investors, especially those in Mataram, which is the object of this research. In addition, the uniqueness of this study is to use millennial participants from Mataram to evaluate the behaviour of investors in the capital market. Concepts of behavioural finance theory include overconfidence theory and financial cognitive dissonance theory. This research is expected to empirically prove the theory of planned behaviour, economic dissonance bias theory and overconfidence theory in behavioural finance theory as a theory that supports investment decisions in the millennial generation. This research is expected to provide various utilities to the broader community to obtain additional information related to things that must be considered before investing, especially in behaviours that can cause investors to do things that are detrimental to themselves. For financial and educational institutions, the results of this research are expected to be used as motivation to provide intensive train-

ing and seminars related to investor attitudes and behaviour, whether deviant or not.

METHODS

In this research, the associative research method is used, which aims to determine the relationship between the variables studied [23]. Quantitative methodology is used in this research to collect data in numerical form (numbers) to be tested and analyzed to obtain generalizable scientific results [17]. The respondents in this research are millennial generation investors in Mataram. The reason for choosing a research location for investors in Mataram is because Mataram is a city where researchers are located and can be reached by researchers. This research was conducted by distributing questionnaires to investors in the Mataram who participate in securities companies that actively operate online stock transactions on the stock exchange.

In this study, the population of Mataram City who invests in the capital market cannot be known with certainty. So, determining the number of samples used is using the purposive sampling technique. Regarding the qualifications used to determine the respondents for this research, they are (1) Millennials born in the 1980–2000 period; (2) they have or are currently undergoing investment; (3) Domiciled in Mataram City.

To calculate the sample in a population that is not known with certainty in this research [21]:

$$n = \frac{(\frac{Z_a}{2} \times \sigma)^2}{e^2}, \quad (1)$$

$$n = \frac{(1,96) \times (0,25)^2}{0,05^2} = 96,04$$

where n – sample value; Z – level of confidence/significance; e – 5% margin of error; n – level of significance.

With 95% confidence or $Z = 1.96$ and $e = 0.05$. The calculation results show that 96.04 respondents or rounded up to 100 respondents. The statements in this research are measured using a Likert scale of 1 to 5. Structural equation modelling (SEM) was used to evaluate and test research data using smart PLS software. In this research, the measurement used is reflective form measurement, which shows that variance is a manifestation of a latent construct, where all indicators

move together so that if there is a change in one indicator, it will change the other indicators. In the reflective form, it is assumed that the manifestation variable can measure the indicators that form the construct with the latent variable.

$$KI = \alpha + \beta_1 FL + \beta_2 HB + \beta_3 OC + \varepsilon \quad (2)$$

KI – Investment Decision; FL – Financial literacy; HB – Herding behaviour; OC – Overconfidence; α – Constant regression coefficient; β_1 – Regression coefficient of each proxy; ε – Error term.

The steps of the research method using a structural equation modelling approach through smart PLS is to test the outer model, which is carried out using the convergent validity test, discriminant validity, composite reliability, Cronbach alpha and goodness fit of the model test, and inner model analysis, including R^2 , Q^2 Predictive Relevance, Path Coefficient and hypothesis testing.

The hypotheses of this research are:

H₁ – Financial literacy has a positive and significant effect on investment decisions in Millennial Generation;

H₂ – Herding behaviour has a positive and significant effect on investment decisions in Millennial Generation;

H₃ – Overconfidence positively and significantly affects investment decisions in Millennial Generation.

ation. This research applies a one-tailed test so that the t-table used in this research is 1.67.

RESULTS AND DISCUSSION

The West Nusa Tenggara capital market is dominated by millennial investors, according to the Indonesia Stock Exchange (IDX) in Mataram, where the number of investors aged 18 to 25 years has reached 16,471 (SID). Then investors in the capital market aged 26 to 30 years with 6,341 SID and investors aged 31 to 40 years with 5,811 SID. The total SID for investors aged 41 to 100 is 3,583. The research questionnaire was made from the questionnaire used in previous studies. With a sample of 100 Mataram city respondents, the purpose of descriptive statistical analysis is to provide an overview of each data for both exogenous variables, namely financial literacy, herding behaviour, and overconfidence and endogenous variables, namely investment decisions.

Outer Model Test Results

The validity of the study was tested. The first is discriminant validity testing. This test is used to confirm that each statement represents the concept of the variable for discriminant validity testing. For discriminant, validity testing is observed through a cross-loading score. This test ensures that each statement indicator has a different concept.

Table 1 – Discriminant Validity Test Results

Indicator	Investment Decision	Indicator	Financial literacy	Indicator	Herding behaviour	Indicator	Overconfidence
KI1	0.641	FL1	0.735	HB1	0.934	OC1	0.757
KI2	0.615	FL2	0.629	HB2	0.939	OC2	0.875
KI3	0.688	FL3	0.608	HB3	0.906	OC3	0.897
KI4	0.691	FL4	0.660	HB4	0.893	OC4	0.821
KI5	0.746	FL5	0.624				
KI6	0.695	FL6	0.800				
KI7	0.777	FL7	0.717				
KI8	0.778	FL8	0.756				
KI9	0.723	FL9	0.693				
		FL10	0.743				
		FL11	0.801				
		FL12	0.756				

From table 1, the results of the discriminant validity test can be seen that some statement indicators get an outer loading below 0.7. Such as the indicators KI1, KI2, KI3, KI4, and KI6, which successively get an external loading value of 0.641, 0.615, 0.688, 0.691 and 0.695, are indicators that explain investment decision variables, FL2, FL3, FL4, FL5, FL9 which have an outer loading value of 0.629, 0.608, 0.660, 0.624 and 0.693. Several indicators with an external loading value below 0.7 indicate that the indicators for investment decision variables and financial literacy have low

validity because they do not meet the loading requirements. So based on this, before the next test is carried out, the invalid indicator must be removed (dropping), but after dropping, it is found that there are still indicators that have an outer loading below 0.7, so the deletion is carried out again for the second. A re-calculation is carried out to give confidence that the external loading value is above 0.70. Table 2 shows the results of the second retest (dropping) for the discriminant validity test.

Table 2 – Discriminant Validity Test (Dropping)

Indicator	Investment Decision	Indicator	Financial literacy	Indicator	Herding behaviour	Indicator	Overconfidence
KI5	0.751	FL1	0.758	HB1	0.935	OC1	0.738
KI7	0.883	FL6	0.738	HB2	0.940	OC2	0.883
KI8	0.829	FL8	0.770	HB3	0.906	OC3	0.906
KI9	0.828	FL10	0.834	HB4	0.891	OC4	0.822
		FL11	0.846				
		FL12	0.837				

Then, a re-calculation is carried out to confirm that the outer loading value is above 0.70. Table 2 shows the results of the second retest (dropping) for the discriminant validity test. Then, a re-calculation is carried out to confirm that the outer loading value is above 0.70. Table 2 shows the results of the second retest (dropping) for the discriminant validity test.

Based on table 2, after the deletion test, it can be seen that all indicators have discriminant validity values above 0.7. Therefore it can be interpreted that the discriminant validity test of all statements for all variables is said to be valid, and then the concurrent validity test is carried out. Convergent and discriminant validity tests were used in this research to test the validity. The calculation of the contemporary validity test of this research can be seen in table 1. In this research, the convergent validity test is applied to know the validity of the variable and to find out whether the variable has a good construct. This test is measured using the average variance extracted (AVE) score. Discriminant validity testing in this research was assessed based on the rule of thumb with the average variance extracted (AVE) value required to be above 0.50 [13]. Table 3 shows the results of AVE from the Convergent Validity test.

Table 3 – Convergent Validity Test Results

Variable	Average Variance Extracted
Financial literacy	0.637
Herding behaviour	0.843
Overconfidence	0.705
Investment decision	0.680

The validity of each indicator variable used is assessed using convergence validity. Assuming the variable has a high correlation with the component, this test aims to ascertain whether the variable is an accurate representation of the element. The results of table 3 show that the AVE value is more significant and higher than the 0.5 (rule of thumb) used in determining convergent validity in this study. This means that the fact of all variables is declared valid.

The composite reliability and Cronbach alpha reliability tests were used to conduct the reliability test in this research. The purpose of this reliability test is to establish the level of confidence in the variables under consideration. The general rule is that the value must be greater than 0.7, but 0.6 is still acceptable [13].

The two reliability tests (Table 4), composite reliability and Cronbach's alpha, show that the reliability value is above 0.70 or higher.

Table 4 – Reliability Test Results

Variable	Cronbach Alpha	Composite Reliability
Financial literacy	0.886	0.913
Herding behaviour	0.938	0.956
Overconfidence	0.859	0.905
Investment Decision	0.843	0.894

Therefore all variables in this research are considered reliable. It was determined that the questionnaire used was consistent and reliable.

Next is the goodness of fit model test, which is carried out to evaluate the suitability of the research model. If the SRMR score is < 0.10 , it can be interpreted that the research model is feasible. The research model is not viable if the SRMR value is > 0.15 . In this research, the fit model test produces the results in Table 5.

Table 5 – Goodness of Fit. Test Results

	Saturated Model	Estimated Model
SRMR	0.072	0.072

The test results show that the SRMR value is 0.072 based on this study's test findings. It shows that the structural formula used in this study can be applied.

Inner Model Test Results. Furthermore, testing is carried out for the inner model in this research. This study's internal model tests the coefficient of determination R^2 , Q^2 predictive relevance, path coefficient and hypothesis testing. The coefficient of determination test is seen through the R^2 assessment of 0.67, 0.33, and 0.19, which implies forming a strong, moderate and weak research model. The better the prediction value is given, the stronger the coefficient of determination proposed.

Table 6 – Results of the Coefficient of Determination

Variable	R^2
Investment decision	0.531

The R^2 -test can be seen that be 0.531. Therefore, it can be concluded that the R^2 of this research is included in the high category. Furthermore, the Q^2 test can be seen based on blindfolding in the

cross-validated redundancy construct section. Where in this study, measured from the value of Q^2 predictive relevance, the quality categorization of Q^2 is 0.02 (weak), 0.15 (medium/moderate), and 0.35 (large). Table 7 shows the results of the calculation of the Q^2 test.

Table 7 – Q^2 Predictive Relevance Test Results

Variable	Q^2
Investment decision	0.326

Based on the test in table 7, it is found that the value of Q^2 is 0.326. This result can be interpreted as the relative impact of the structural model on the measurement of endogenous variables is quite large. Furthermore, testing is carried out on how strong the effect and influence of exogenous variables on endogenous variables is by conducting a path coefficient test.

The influence of financial literacy on investment decisions is 6.347, as shown in Table 8, reflecting the highest path coefficient value.

Table 8 – Path Coefficient. Test Results

Variable	mean	STDEV	t-values
Financial literacy	0.578	0.091	6347
Herding behaviour	0.011	0.070	0.143
Overconfidence	0.187	0.088	2,065

Overconfidence in investment decisions has the second most significant effect, with a t-value of 2.065. In contrast, the slightest impact is indicated by the value of the herding behaviour variable of 0.143 for investment decisions.

Hypothesis Test Results. Hypothesis testing of this study was assessed through t-statistic scores and probability scores. It is done by comparing the statistical value with the t-table value and the p-value score with 5% alpha, and the t-statistic score used is 1.67. The following are the results of hypothesis testing in this study.

Table 9 – Hypothesis Testing Results

Variable	t-values	p-values
Financial literacy	6.347	0.000
Herding behaviour	0.143	0.443
Overconfidence	2,065	0.020

Based on the test results, the financial literacy variable has a t value of 6.347.

The t-value of this test is greater than the t-table value, which is $6.347 > 1.67$. Furthermore, the p-value for financial literacy is $0.000 < 0.05$, so H_1 is accepted, that is, there is a positive and significant relationship between financial literacy to investment decisions, which has a substantial impact on investment decisions, investment decisions increase along with increasing financial literacy.

The t-value of the herding behaviour variable is $0.143 < 1.67$, which is smaller than the t-table value. The p-value of herding behaviour is $0.443 > 0.05$, which is greater than the alpha value. From this, we can conclude that H_2 is rejected. This shows that herding behaviour does not positively and significantly impact Millennials' investment decisions. This table also indicates that overconfidence has a positive and statistically significant effect.

The result of t value $2.065 > 1.67$, which is greater than the value in the t table, and the p-value of overconfidence is $0.020 < 0.05$, so H_3 is considered accepted. This shows that overconfidence influences the millennial generation's investment decisions positively and significantly. The Overconfidence of Mataram investors can explain this in their investment decisions. And the p-value of overconfidence is $0.020 < 0.05$, so H_3 is considered accepted. This shows that overconfidence influences the millennial generation's investment decisions positively and significantly. The overconfidence of Mataram investors can explain this in their investment decisions. And the p-value of overconfidence is $0.020 < 0.05$, so H_3 is considered accepted. This shows that overconfidence influences the millennial generation's investment decisions positively and significantly. The overconfidence of Mataram investors can explain this in their investment decisions.

Influence of Financial Literacy on Millennial Generation Investment Decisions. It can be concluded from the test that investment decisions have a positive and significant impact on the financial literacy aspect of the millennial generation of Mataram City. The test results align with research by [2], stating that financial literacy positively and significantly affects millennial investment decisions. This research provides insight into the importance of financial literacy for millennial investors in Mataram before making investment decisions. Investors will pay attention

to investments that will be considered fundamentally and technically wise because financial literacy assesses the ability of investors to handle their finances. Investors can manage their finances by making intelligent choices for long-term and short-term financial planning. Investors also understand financial concepts. This means that the increasing financial literacy of the millennial generation in Mataram allows investors to be better at making decisions regarding investment. This research's findings align with the theory of planned behaviour, showing that investors have control over the knowledge and information available to make wise decisions.

The Influence of Herding Behaviour on Millennial Generation's Investment Decisions. This study finds that herding behaviour does not positively and significantly affect investment decisions. This Millennial Investment Decision does not imitate the decisions that other investors observe or financial market movements when investors in Mataram make investment decisions, or millennial investors in Mataram make investment decisions based on their beliefs and information, contrary to the study conducted by [20], which says that there is an effect of herding on investment decisions. Instead, it is in line with the study [16], which proves that there is no influence of the herding behaviour variable on the investment decisions of the millennial generation. Millennial investors base their investment choices on their analysis, judgment, and information. And that sufficient information is provided to investors to make informed decisions about their investments without relying on the review or knowledge of other investors. The results of this study contradict the financial cognitive dissonance bias theory, where the theory states that investors tend to follow other investors if new and existing information received from other investors is not balanced.

The Effect of Overconfidence on Millennial Generation Investment Decisions. This research found that the level of overconfidence of millennial investors in the Mataram is high, as indicated by the results of hypothesis testing. Investors with high confidence believe they have more investment knowledge and expertise than other investors. This research is in line with the study [1], which proves that overconfidence affects investment decisions. This confidence in investors often causes investors to make mistakes in analyzing stocks which can lead to errors in investment decisions. The results of this study confirm

the overconfidence theory in behavioural finance theory, which explains that individuals can overestimate their abilities from the information they have received.

CONCLUSIONS

Based on the survey results, financial literacy and overconfidence positively and significantly affect investment decisions for millennial Mataram, but the herd behaviour variable does not. These results indicate that investors in Mataram have a good understanding of the capital market. Still, it

does not rule out the possibility that investors may engage in discriminatory behaviour such as overconfidence which is proven to affect investment decisions. The findings of this research confirm the theory of planned behaviour as a theory that supports the occurrence of investment decisions through financial literacy.

This research also confirms the financial dissonance bias theory and overconfidence theory, which reveals that there are psychological factors for investors when making investment decisions.

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A Phenomenological Study on the Feelings, Challenges and Difficulties Experienced by Information Technology Students in Learning Computer Programming

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Abstract. This study aims to identify the experiences of information technology (IT) students in learning computer programming. Specifically, the feelings towards learning programming and the challenges and difficulties encountered by IT students were determined. The researcher used a phenomenological approach to determine the commonality of lived experiences among the students. The study was conducted during the second semester of Academic Year 2020–2021. The participants were first-year students enrolled in a computer programming I course. Open-ended questions were employed to gather responses. Since the data gathering happened during the coronavirus 2019 pandemic, the researcher used Google Form to collect responses. Participants were informed that the responses gathered were treated with the utmost confidentiality, security, and anonymity, following ethical research guidelines. Results revealed that participants have both positive and negative views about learning programming. As to the feelings towards learning computer programming, analysis shows that positive emotions include excitement and good happy feelings towards writing programs and finding them fun, challenging, and engaging. Negative feelings include being nervous, anxious, confused, and having difficulty learning how to write programs because it is hard. The challenges and problems encountered by IT students include difficulties relating to the program's syntax, errors and debugging processes; lesson-related; algorithm, analysis, resources, teaching, time-management, and personal factors. The researcher suggests recommendations that would improve the quality of teaching computer programming and offer new possible topics for future studies.

Keywords: challenges and difficulties; computer programming; lived experiences; phenomenological; qualitative.

INTRODUCTION

The field of information technology (IT) continues to grow, and the demand for IT professionals increases as humans realize the importance of IT in various fields and disciplines. Expertise in the information and communications technology field has become necessary to address the demands of different industries [1]. Information technology involves storing, retrieving, and sending information, which has become a vital component of everyday lives. IT is the "study of systematic approaches to select, develop, apply, integrate, and administer secure computing technologies to enable users to accomplish their personal, organizational, and societal goals" [2].

IT allows access to any information [3]. With the growing number of integrated systems and modern computing techniques and infrastructure, such as the cloud, access to information has become more accessible. IT also saves time in complex tasks and fosters innovations [3] in different sectors like education, business, healthcare, transportation, agriculture, and governance.

In recent years, IT has facilitated communication [3]. With improved and efficient communication tools through IT, opportunities and improvements have been achieved in different areas of society. Social media, for instance, has allowed people from other parts of the world to be easily connected. IT also evidently helps the education sector, especially during pandemics. With differ-

ent communities' much-needed strict restrictions to control the spread of Coronavirus 2019 (COVID-19), teaching and learning processes have still been conducted. The shift to online and flexible learning allowed students to continue learning in the comfort of their homes while ensuring safety and security.

The business sector has also benefited from IT. Operations and business processes have been improved using different computerized systems and tools. Opportunities have been created, and improvements have been achieved, which have benefited society. Marketing goods and services have dramatically improved with the use of different IT platforms. Thus, economic progress and a better quality of life for everyone are continuously achieved.

Writing computer programs is one of the essential skills for individuals wanting to pursue a career in information technology and related computing disciplines. In the Philippines, the Commission on Higher Education (CHED) laid guidelines for the higher learning institutions intending to offer or currently offering information technology and related computing programs through the CMO 25 series of 2015. This document sets the policies, standards, and guidelines for undergraduate programs in information technology, computer science, and information systems [4]. Programming is at the core of these computing programs. Thus, learning and developing this skill is a must for computing professionals.

Computer programming is writing instructions in a language machine understand to perform the desired process. The written machine instructions are called computer programs [5]. This set of codes, which the computer understands, performs functions and procedures to provide meaningful output relevant to end-users. A group of skills must be developed to write a computer program effectively. Skills in designing the algorithm, writing the program, understanding the syntax of the programming language, applying the correct logic, and the ability to use an integrated development environment (IDE) in constructing programs are necessary skills [6][7].

The mastery of a programming language is necessary for writing a program [8]. Today, various programming languages have been made available for professionals to develop computer programs effectively. Programming languages are classified into object-oriented programming lan-

guages, logic programming languages, procedural programming languages, functional programming languages, and scripting programming languages [9]. Another critical skill is debugging and problem-solving [8]. An individual needs to possess these skills because writing solutions to real-world problems is one of the ultimate goals of programming. Finding answers and translating them into codes is easier for an individual with good problem-solving skills. Logical and abstract thinking [8] is another essential programming skill. In writing programs, one must understand how to think logically to solve problems. Also, looking at issues and solutions in an abstract state helps create practical outputs. In addition, communication skills [8] are essential programming skills. Programmers must be able to effectively express their thoughts and ideas to others to effectively find solutions to existing problems and open opportunities for collaboration. Another skill one must develop is an eye for detail [8]. Writing programs require individuals to look into more information clearly to provide the expected output and solutions. Lastly, individuals must be good at memorizing [8]. Since many programming languages are available today, programmers must be very familiar with their language. While syntax may differ from one programming language to another, it is essential to deeply understand the similarities in structure, concepts, and use.

Learning programming languages and writing programs can be considered challenging tasks by students [10], especially for those with a weak logic and problem-solving foundation and those who lack materials to use, such as computers. Students must understand the problem, formulate the solution using standard problem-solving procedures and techniques, and write the solution using a programming language for computers to understand and execute to produce the expected output [11]. However, writing computer programs has been one of the challenges that students are experiencing, especially those with a weak foundation in logic, mathematics, critical thinking, and problem-solving. Many novice students have difficulty writing programs, which may lead to programming anxiety. In a study [12], researchers found that females tend to be more anxious about programming than males. However, in the same study, they also found out that the anxiety of females positively affects their academic performance. Thus, an increase in their

programming anxiety may also contribute to the improvement in their academic performance.

Previous studies have presented challenges and difficulties experienced by students [1][6][11], and the present study aims to contribute to the growing body of literature. The study focuses on the feelings, challenges and difficulties encountered in learning programming by first-year college students enrolled in the information technology undergraduate program. The study results may become a basis for crafting a plan of action to improve the quality of the teaching and learning process.

This study seeks to answer the following research questions:

1. How to describe the feelings toward learning programming IT students?
2. How do you explain IT students' challenges and difficulties writing computer programs?

The study focused on the feelings towards challenges and difficulties the selected first-year students encountered in learning programming from the course Computer Programming I during the first semester of Academic Year 2020–2021. Results were only drawn and analyzed from the responses of student-participants using open-ended questions.

METHODS

The study used a phenomenological type of qualitative research to identify the participants' lived experiences in learning programming. Phenomenological research seeks commonality within a particular group to arrive at a description of specific expertise or phenomenon [13]. The lived experiences of the IT students gathered using this approach provide an understanding of the feelings, challenges and difficulties encountered. This may result in developing a plan of action to mitigate the negative impact of such experiences in learning to program. Further, the results can also be a basis for improving instructional strategies in teaching programming.

The study was conducted during the second semester of Academic Year 2020–2021. Three hundred forty-eight (348) first-year students enrolled in computer programming I served as participants in this study. In the data gathering, the researcher employed a data gathering tool with open-ended questions about their feelings to-

wards learning programming and the challenges and difficulties they encountered in writing programs. The conduct of data gathering happened at the time of the coronavirus 2019 pandemic. Thus, the researcher used Google Forms to collect online responses from the participants. The researcher ensured that the participants' answers to open-ended questions were treated with the utmost confidentiality.

RESULTS AND DISCUSSION

IT Students' Feelings Towards Programming. The results of the analysis on the most common feelings towards programming are shown in Figure 1.

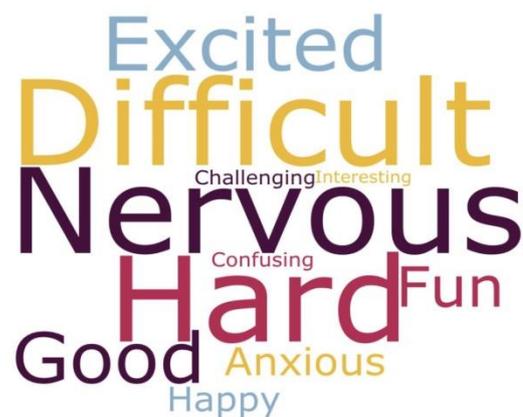


Figure 1 – Word cloud of the most common keywords mentioned about the feelings of IT students towards programming

Answers to open-ended questions revealed that participants had 55% positive and 45% negative feelings. The researcher extracted these positive and negative feelings expressed, and the results showed that in terms of negative emotions, students said that learning programming brought them feelings of being nervous (19.80%), anxious (4.60%), and confused (2.30%). In addition, participants expressed that learning programming is hard (17.5%) and difficult (14.66%). Described below are some of the responses of the student-participants:

"I felt programming is difficult and requires us to study hard".

"I feel nervous about writing programs; some parts are hard to understand".

"It is not easy for me. I feel so stressed sometimes when I don't get the right code running".

"Programming is not easy. Whenever our professor gives us an activity, I feel nervous because I am not good at programming".

"For me, at first, programming is not easy to understand. I feel uncomfortable and nervous at the same time".

"I felt uncomfortable writing programs because I think it is not easy to understand and I am not fully equipped with the things I needed to possess when programming".

"At first, I thought it was easy, but when problems were given to us, I feel like I cannot answer them".

"Palagi pong kinakabahan sa takot na magkamali" (Feeling nervous because of the fear of making mistakes).

On the other hand, student-participants positively expressed that learning programming brings them feelings of excitement (8.90%), fun (6.61%), and happiness (4.02%). Also, students felt good (8.33%) about learning how to write a program because they thought it was challenging (2.30%) and interesting (2.01%). The following statements are some of the responses of the student-participants to the open-ended questions.

"I feel excited to learn how to write programs even if it may be difficult".

"Programming boosts my confidence when I know that my program works. Though there is a feeling of nervousness, being proud is much greater".

"Learning how to write programming is a challenging and fun experience for me." "I feel happy, curious, and excited when we are talking about programming. It is fun when we are doing it".

"I felt inspired thinking about successful programmers and others who have created their programs".

"I feel good about programming. It is exciting to learn".

The expressed feelings about learning programming by the student-respondents are familiar to novice programmers. Authors [14] explain different emotions that novice programmers experience during their first computer programming learning session. Primary emotions include flow

and engagement, confusion, frustration, and boredom. On the other hand, curiosity, happiness, anxiety, surprise, anger, disgust, fear, and sadness are rare feelings experienced. The perception of the student-participants that learning to program was difficult is supported by the studies of [15-17], expressing that programming in higher education requires problem-solving and higher-order thinking skills. Thus, students must develop these skills to excel in a computing discipline.

The feelings of anxiety, panic, and stress when unable to solve programming errors [18] have been reported as experienced by novice programmers. Negative emotions may lead to sorrow and despair [19], and giving up may lead to transferring to other degree programs when students cannot overcome them. These feelings toward learning programming should be addressed by appropriate intervention activities and programs that can lead to a more effective teaching-and-learning experience.

Challenges and Difficulties Encountered in Learning Programming. Figure 2 presents the most common challenges and difficulties in learning programming through a word cloud.

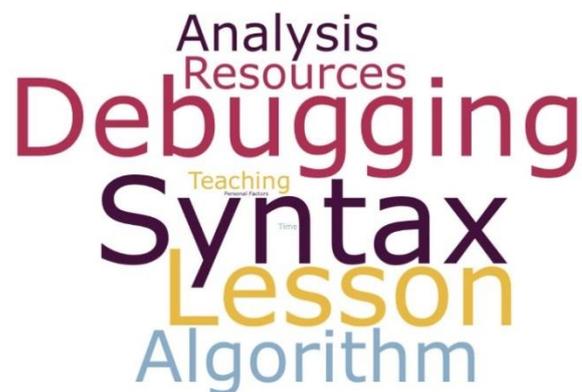


Figure 2 – Word cloud of the most common keywords mentioned about the challenges and difficulties encountered by IT students in learning programming

The top-most challenge and difficulty experienced by student participants involved writing the syntax (28.16%). They expressed that writing computer programs alone is already challenging because they need to be familiar with the programming language, its syntax, operators, and ways to write them. This is followed by debugging (11.78%). Student-participants assert that

finding errors and solving them is the next challenging task when learning to program. Meanwhile, lesson-related difficulties got 11.49% of the responses of the participants. It is found that understanding the topics such as decision statements, iteration statements, and other essential information needed in programming is challenging.

On the other hand, writing algorithms (7.76%) was also expressed as a challenging activity for students. Applying appropriate algorithms to programs requires in-depth analysis. Thus, analyzing (5.46%) followed after this. For some, their resources are a significant concern. Students have difficulty learning programming because of the lack of resources such as computers (4.89%). Others find it difficult to understand how instructors discuss (2.58%), manage their time (.86%), and other personal factors (.57%). The student-respondents expressed the following statements about the challenges and difficulties experienced in learning programming.

"I have no computer to use to practice writing programs".

"It is difficult for me to write the syntax. Most of the time, I forget to use symbols like semicolons properly, which results in errors in my program".

"Some lessons are hard to understand, like looping".

"Applying the correct logic for the program or proper algorithm is difficult".

"Finding errors in my program is challenging. Sometimes I don't know why my program doesn't run even if the code is correct".

The challenges and difficulties identified and analyzed from the responses of the student-participants provide a clearer view of how to im-

prove the teaching and learning process to have a more effective and quality IT education.

CONCLUSIONS

Based on the findings of this study, the following conclusions were drawn:

1. Feelings toward learning to program by IT students are classified into positive and negative. Positive emotions include excitement and good happy feelings towards writing programs and finding them fun, challenging, and engaging. Negative feelings include being nervous, anxious, confused, and having difficulty learning how to write programs because it is hard.

2. The challenges and difficulties IT students encounter include problems relating to the program's syntax, errors and debugging processes; lesson-related; algorithm, analysis, resources, teaching, time-management, and personal factors.

3. Identified feelings towards programming and the challenges and difficulties experienced by IT students can be a basis for a plan of action in the college.

The following recommendations are presented based on the conclusions made:

1. Instructors teaching programming courses may consider employing classroom activities to boost the students' motivation and interest to lessen the discipline's negative perception. This will also lead to the effective development of programming skills.

2. Innovation in teaching strategies and materials may be considered to lessen the challenges and difficulties experienced by students.

3. An intervention plan of action may be crafted to improve the teaching of programming courses.

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Administrator Leadership Training at the Regional BPSDM of West Nusa Tenggara Province in terms of Planning Aspects

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Abstract. This study aimed to identify and explain the planning for implementing administrator leadership training at the Regional BPSDM of West Nusa Tenggara Province. This study uses a qualitative research type utilising a case study approach. Sources of data in this study use primary data sources and secondary data. They collect data in this study using observation techniques, interviews, and documentation. Data analysis is based on data collection, data display, and checking the validity of the data using the test of credibility, transferability, dependability, and confirmability. The results showed that the planning process for administrator leadership training includes: an analysis of training needs, participation, training personnel, facilities and funding.

Keywords: planning; training; leadership.

INTRODUCTION

Improving the quality of human resources, especially the State Civil Apparatus (SCA), is very important [1] because SCA is the main element of the country's human resources, which has a very decisive role in the progress of the nation. So creative, innovative and professional staff are needed to carry out government and development tasks. Success in government administration and development cannot be separated from the SCA role. Therefore, it is necessary to effectively manage the government apparatus's human resources (civil servants). Their competence can be developed through education and training.

Every SCA with an echelon III position must have managerial competence that can be measured through the level of education, structural or management training, and leadership experience. The product of the education and training process is output – alums of training participants. The product's benefits are in the form of outcome – the effect of training on the actual performance of a training participant.

An administration official will needed who is responsible for leading the implementation of all public service activities and government admin-

istration and development for the sustainability of organisational units. Namely, in improving the performance of administrative units carried out by supervisory officials and implementing officials in providing public services. Since employees are important assets of organisations/agencies engaged in services that rely on the employees' productivity level, employees are required to optimise their productivity.

Public services that are managed and controlled correctly are an integral part of improving the quality of organisational unit performance [4]. The figure of administrator who can play this role is an official who meets the criteria of performance management leadership. It can be realised through education and training of administrator leadership, a form of structural leadership training.

The Government Regulation (No 17, 2017) concerning Civil Service Management stipulates that to be appointed to the administrator position must have qualifications through structural training in administrator leadership. Through the Regulation (No 16, 2019) concerning Administrator Leadership Training (ATL), it is explained that ATL is an activity in improving the expertise or competence of performance management

leadership in the form of skills, knowledge, and behavioural attitudes that can be observed, measured and developed in carrying out the duties of their position as administration officials. The objective of the ATL is for echelon III structural officials to demonstrate their performance in leading and designing a change related to the policy direction of sectors, regions, and national strategic issues.

ATL is an effort to improve managerial competence for administrator officials to meet the competency standards of the position and actualise their competence in performance leadership and performance management by their areas of expertise and duties by doing four basic things. Namely, innovation, collaboration, and optimising all potential internal and external resources to improve organisational performance, government administration and agency development.

The Provincial Government of West Nusa Tenggara is one of the provinces that carries out Level III ATL for echelon III structural positions. Organising the training includes planning, preparation, implementation and evaluation, which becomes a unified activity/work and is carried out in the training performance.

The management of the ATL starts from the process of forming the committee.

The composition of the organising committee for organising the ALT was 13 people with 11 positions on the committee, namely: person in charge, chairman, secretary, members of technical affairs and general administration, and members with experience in the preparation of infrastructure facilities.

The training was carried out at the Regional Human Resources Development Agency (Regional BPSDM). There are 32 participants in the 2021 Training with the following details: Mataram City – 5, West Sumbawa – 2, Dompu – 4, Bima – 15, West Lombok Regency – 5, NTB Provincial KPU office – 1 person.

The expectations expressed in the ALT are:

- training of echelon III officials (administrators);
- administrator officials who can knowledge, skills, and behavioural attitudes to carry out the duties of their positions;
- administrator officials who understand the concepts of service and work control, understand

the ability to formulate, perform, innovate, adopt and adapt service leadership and work control;

- administrator officials can develop the character and behaviour of Pancasila, which integrity, upholding bureaucratic ethics with a national perspective, and being responsible for leading all public service activities in its agency units.

Training management is an effort to ensure the training process runs according to predetermined expectations. The primary functions in managing ALT are planning, preparing, implementing, and supervising/controlling, which have been regulated in the manual for implementing ALT. Based on the report on the implementation of the ALT in 2021 shows several obstacles that occur so that these activities are optimal:

- the lack of coordination between the committee and the fields involved in the implementation of the training;
- the lack of facilities and infrastructure. The fatal thing is that there are 76 confirmed positive Covid-19 participants in the Basic Training CPNS NTB Province. The head of the NTB Province BPSDM decided to return the ALT participants to their respective institutions and continue virtual (online) training activities through zoom meetings.

Therefore, there is a need for improvements that must be made by the implementing committee for the ALT so that it can minimise obstacles that might occur in the future. All 32 participants in 2021 were declared to have passed with a satisfactory average graduation qualification of 26 people and very acceptable as many as six people.

The success of the ALT program in the NTB Province Regional BPSDM is the commitment of the entire implementing committee to managing the process of the training activities. Through a stringent management process, the obstacles that occur can be adequately handled by the ALT Committee to get satisfactory results and implement the training as expected.

Based on this, researchers are interested in describing the planning, implementation, and evaluation of the performance of ALT. This study aims to determine and explain the planning for implementing ALT in BPSDM West Nusa Tenggara Province.

METHODS

This research was conducted at the Regional Human Resources Development Agency (BPSDM Daerah), Mataram City, NTB. This research uses a descriptive qualitative design, which produces descriptive data in the form of written or spoken words from people or behaviours that can be observed. This study used three stages: description, reduction and selection.

The data in this study consists of two types, namely primary and secondary data. Primary data is information obtained by a researcher directly from respondents, while secondary data is information obtained by a researcher from oral and written sources [10]. The data of this research are data regarding the management of ALT at the NTB Regional BPSDM, including training planning, implementation and evaluation.

Data collection in qualitative research use three ways: observation, interview, and documentation. Qualitative data analysis takes place during the data collection process rather than after the completion of data collection. Data collection flows of concurrent activities are data collection, data display (data presentation), data reduction (data reduction) and conclusion drawing/verification (concluding). The data that has been collected needs to be tested for validity. Techniques in testing the validity of the test credibility, transferability, dependability, and confirmability.

RESULTS AND DISCUSSION

Preparation of ALT activities. It begins with looking at the needs of each OPD in the province and the Regency(City) by coordinating with the fields involved in the BPSDMD NTB Province.

The steps are not from the LAN's general education and training guidelines. Coordination is a form of the initial planning for the implementation of ALT, where planning is the process of determining objectives and implementation guidelines by choosing the best from the available alternatives, such as selecting goals, policies, procedures, and programs [6].

Coordination in the ALT involves 13 work units, namely:

- 1) Head of BPSDM Ntb Province;
- 2) Secretary of the Agency;

- 3) Head of Competency Certification and Institutional Management;
- 4) Head of Technical Competency Development;
- 5) Head of Managerial and Functional Competency Development;
- 6) Sub-field of Standardisation of Learning Devices;
- 7) Sub-field of Planning for Development of Functional Management Competencies and institutional management;
- 8) Sub-field of development of Managerial and Functional Competencies managerial and functional competencies;
- 9) Program and Finance Subdivisions;
- 10) Training implementation team;
- 11) Curriculum drafting team;
- 12) Evaluation instrument drafting team and learning outcomes;
- 13) Teaching material drafting team.

Planning for ALT at BPSDMD NTB Province includes an analysis of training needs, participation, personnel, facilities and funding. The initial process in planning is an analysis of the competency needs of human resources within the Civil Service environment because the rank, class and position of employees will affect their productivity. Needs analysis in the planning process of ALT at BPSDMD NTB Province is carried out every year, intended for implementation the following year. A needs analysis is carried out if the need exists. Determination of conditions must be based on proper analysis because the implementation of training requires a large number of funds [8].

Each of these units conducted a needs analysis to ensure echelon III officials from each Regency/City Region in NTB participate in the Administrative Leadership Training. Needs analysis is the initial training/education management process to determine goals, identify inequalities between targets and reality, and set action priorities in training activities [9]. Analysis of training needs is oriented towards the interests of (prospective) participants, not solely to the interests of organising training programs [7]. Because basically, the outcomes that will be produced in training are in the form of characteristics or profiles of prospective study participants, identification of gaps, identification of needs and detailed task analysis based on needs [3]. Training needs include special training needs consulted with ex-

perts, and training objectives reflect specific training needs [8].

The implementation of ALT requires a core committee as the training manager. Where the committee's duties as managers are [5]:

- (1) Take care of training needs,
- (2) Develop training policies and procedures,
- (3) Manage training budgets,
- (4) Develop and implement training administration,
- (5) Research appropriate training methods to be applied,
- (6) Prepare training facilities and equipment,
- (7) Analyse and improve training systems.

The organising committee was by the decision of the Governor of NTB No. 239-100 of 2021 concerning the formation of an implementing committee for implementing ALT within the scope of district/city governments throughout NTB. The contribution pattern for the 2021 fiscal year stipulates as many as 12 members of the committee, namely:

1. Head of the Regional BPSDM of the Province of NTB – Person in Charge.
2. Head of the Division of managerial competence development of the NTB Province BPSDMD – Chairman of the ALT Organizer.
3. Head of Sub-Division Development of Leadership Competencies of BPSDMD NTB Province – Secretary.
4. Implementers in Competency Development of the NTB Province BPSDMD – Four members.
5. Implementers at BPSDMD NTB Province – four picket officers.
6. Implementers at the People's Welfare Bureau of the NTB Provincial Secretariat – gymnastics Instructor.

The planning process will occur once the budget has been set, where ALT is carried out in a contribution pattern of RP. 22,125,000 per person from each agency to be deposited into the regional treasury sent through the account of the provincial BPSDM revenue treasurer of the NTB province. All of these budgets are allocated according to professional needs.

Authors [9] stated that the components of the training budget include:

- personal: widyasiwara, resource persons, training participants, organising committee, and assistant officers;

- facilities: building/training room complete with facilities and infrastructure, work practice room/laboratory, a field for outbound;

- training teaching materials: books, modules, teaching materials, papers, handouts, stationery, and practice materials;

- supporting tools: computers, copiers, and LCD projectors;

- transportation, consumption, and accommodation: participants' travel costs, widyaiswara's transport, rental of vehicles for shuttles, consumption for participants, widyaiswara, committees, and other people involved in organising the training, and preparing accommodation for hostel accommodation for participants and widyaiswara;

- others: equipment/facility maintenance, health care, insurance.

The Head of BPSDMD of NTB Province is responsible for the success of ALT events.

In the process, the person in charge of the ALT organiser will call the training participants per the number of participants proposed by the authorised officials and meet the requirements set.

The participants of the ALT Batch I 2021 in the scope of the Regency (City) throughout the Province of NTB were attended 32 people: 5 – from Mataram City, 15 – from Bima City, 5 – from West Lombok Regency, 4 – from Dompu Regency, 2 – West Sumbawa Regency, and 1 – the NTB Provincial KPU Office.

Exceeding the minimum number that has been set, there is no need to make written approval from the head of the LAN for implementation decisions. Of the 32 participants who took part in the ALT, they were from different agencies, namely cross-ministerial, cross-institutional and cross-regional. Recruitment of trainees can be the key to determining the success of the next step in training [5], so the recruitment of participants must complete the requirements that have been set.

Participants of the ALT within the district/city of the Province of NTB batch 1 for the 2021 Fiscal Year have the following requirements:

- participant has the potential to be developed as evidenced by the appropriate documents;
- participant has technical competence in the structural position to be occupied, as evidenced by the appropriate documents;

- participant's rank in the minimum group is Kindergarten I –III/d;

- participant able to communicate in English as evidenced by a certificate of Educational testing service test of English for international communication (ETS TOEIC) with a minimum score of 425, or international based test of English as a foreign language (IBT TOEFL) with a minimum score of 35, or international English language testing system (IELTS) with a minimum score of 4.5, or the State Administration agency English Communication Skills for Civil Service Test (LAN ECSCS Test) with a minimum score of 75.

For participants who have not held echelon III structural positions, it is recommended by Baperjakat Agencies to make changes to the echelon III uni.

The trainees' learning experiences (outcomes) are reflected in the workers' skills, knowledge and abilities. Training is said to be effective if the movement results are by the trainees' duties and valuable in their job duties [2].

The follow-up letter of the NTB Regional Secretary (No 800/151/BPSDMD/PKM/2021), where the documentation requirements that ALT participants must bring are:

- 1) photocopy of appointment decree in the last position;
- 2) letter of assignment from an authorised official or official of the supervisory service (PPK) of government agencies as early as participants;
- 3) health information from government doctors, drug-free information and prohibited oats from authorised institutions;
- 4) Covid-19 free information as evidenced by a Non-reactive/ negative certificate (Rapid Antigen Test);
- 5) a statement of willingness to comply with the applicable provisions during the implementation of the ALT and is not in the period of prohibition from participating in the ALT. This statement is stated in the form of facts;
- 6) a letter of assignment to follow the ALT as well as a statement of duty-free at the time of on-campus signed by the Regional Secretary;
- 7) a colour photo with a red background wearing white clothes with sizes 3x4 and 4x6 each three sheets;
- 8) biodata of ALT candidates to be filled out through google form.

ALT must be attended by a minimum of 30 people and a maximum of 40 people. Where these provisions have been set by the State Administrative Institution (LAN) and attached to the ALT implementation guidelines issued by the LAN, suppose the participants exceed the minimum and maximum numbers. In that case, the efforts made as an action by the organising committee are to exercise discretion by writing to the LAN.

Types of training personnel in ALT are teaching staff which include resource persons, widyaiswara, mentors and coaches. All training staff who will teach, educate, foster, guide and train ALT participants are professionals and must meet all the requirements of the LAN.

Namely, resource persons or lecturers are State Officials, Practitioners, SCA, Employees/Members of the Indonesian National Armed Forces, Indonesian National Police, Academics, or Officials of BUMN/BUMD.

Requirements ALT staff who are widyaiswara must have competency certification to teach at the ALT. Widyaiswara as a teacher, must pay attention to the principles of teaching, namely [2];

- 1) pay attention to the relationship between interests and values possessed by participants to generate learning motivation;
- 2) can demonstrate new behavioural models that can be witnessed and imitated by trainees;
- 3) apply open communication.

While the resource persons, experts, and other practitioners have:

- 1) the ability in learning management as indicated by appropriate qualifications, experience and expertise in the ALT program;
- 2) the ability to master the substance of the training subjects is indicated by qualifications, experience, and teaching skills.

The task of a resource person or speaker is to convey information to participants by paying attention to competencies and qualifications by learning needs. The Material Supervisor, who is Widyaiswara, is in charge of facilitating the learning process and has received an assignment from the head of the organising training institution, Widyaiswara as the material supervisor has competence, experience, and expertise in the learning needs of ALT. The most important thing for Widyaiswara is to form the participants' misguided personalities through communicated upbringing, both verbally and non-verbally [2].

The supervisor (Coaches and Mentors) are by their respective duties and functions:

- supervisor explores the potential of participants to carry out learning guidance on Organizational Performance Change Action and get assignments from the leaders of the organising training institutions;
- supervisor is in charge of guiding the participants during the implementation of the off-campus stage.

Mentors are the participants' direct superiors, while coaches are mentors who have competence in (1) equipping participants with the necessary competencies during the off-campus stage; (2) motivating participants through consultation during off-campus implementation.

The ALT facility must be responsive between the needs and the pandemic conditions. So that the procurement of infrastructure needed to organise ALT, among others, are as follows: hall, classrooms, discussion/seminar rooms, computer room, learning facilities by utilising information technology: e-learning applications, video conferencing or other information technology according to learning needs, secretariat room, fitness room, participant dormitory, training staff homestead, library, dining room, sports facilities, entertainment facilities, health units/polyclinics, places of worship. The provision of facilities/facilities and infrastructure is the task of the secretariat of the Agency at BPSDMD NTB Province.

The implementation of ALT use facilities that include: study tables and chairs, whiteboards, flipcharts, sound system, television and video, OHP/OHT, recorder, computer/laptop, LCD projector, network (wi-fi), reference book, mod-

ule/teaching materials, multimedia technology for e-learning.

CONCLUSIONS

The planning process for the ALT at BPSDMD NTB Province includes an analysis of training needs, participation, training personnel, facilities and funding. All elements involved in the ALT training are NTB BPSDMD members who coordinate and conduct a needs analysis for employees taking part in the ALT from echelon III. Before the planning process, the head of BPSDMD coordinates with each sector involved in the ALT. Committees and budgets are essential points in the ALT implementation process.

Planning will take place once the budget is set. Because the budget is the most critical factor in meeting all the needs in implementing the ALT, the funding is allocated according to proportional needs.

Training personnel in ALT are teaching staff which include: resource persons, widyaiswara, mentors, and coaches. The task of a Resource Person or Lecturer is to convey information to participants by paying attention to competencies and qualifications that are by learning needs. The widyaiswara is tasked with facilitating the learning process and has received an assignment from the leadership of the training organisation. The Advisors (Coach and Mentor) explore the potential of Participants to carry out learning to mentor for Action Changes in Organizational Performance and get assignments from the leadership of the training institution.

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Phytochemical Screening, Acute Toxicity and Analgesic Activity of Extracts From *Newbouldia laevis* in Laboratory Animals

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Abstract. Extraction was by cold maceration using methanol. The extract was concentrated in vacuo to yield a brown solid of 120.191 g. The crude methanol extract was partitioned into n-hexane 0.1 g, dichloromethane 2.5 g, ethylacetate 4.6 g, and methanol 10.0 g fractions via coarse chromatography. Secondary metabolites identified; 21.73±0.36% alkaloids, 40.78±0.27% flavonoids, 15.99±0.044% saponins, 6.088±0.06% tannins, 3.086±0.03% terpenoids and 12.13±0.01% Cardiac Glycosides. Acute toxicity test showed no death in the rats administered with low dose (1000 mg/kg) and high dose (6000 mg/kg). Analgesic activities of crude methanol extract and fractions showed that at a low dose of 4000 mg/kg of the extract and the fractions have percentage inhibition of pains as methanol crude (63.48±4.62), methanol fraction (79.14±7.39), dichloromethane fraction (60.79±6.69), ethylacetate fraction (23.26±9.75) and n-hexane fraction (64.82±9.75). At a high dose of 8000 mg/kg, the percentage inhibition of pain was 5200±2.00, 71.87±7.04, 80.31±6.20, 45.61±12.60 and 43.87±8.13. Statistical analysis; P>0.05 confidence level, methanol fraction recorded highest analgesic activities while ethylacetate fraction had least.

Keywords: Alkaloids; Cardiac glycosides; Flavonoids; Pains; Rats.

INTRODUCTION

Africa, particularly Nigeria, has an excellent history of using herbal medicine to treat diverse health problems with indisputable success. This superb traditional practice is transferred from generation to generation. The efficacy of herbal medicine cannot be currently argued locally and internationally. Nature has provided vegetation to humanity, which comprises abundant medicinal plants of different diversities located in different habitats like tropical Rain Forest, Savanna Grass Land, Sahel Savanna and desert regions of the world. The various medicinal plant parts (root, bark, stem, flower, leaves, fruits and seeds) could be used in folklore and allopathic medicine to fight against numerous health challenges [1]. This is done to improve the healthy living of the populace and facilitate the growth of the improved productive economy.

Humanity faces different challenges due to the proliferation of diseases caused by organisms found everywhere in the environment. The author [2] opined that using plants to manage and treat diseases is an age-long practice. According to him, it has been found that many plants possess medicinal value, and different parts of these plants have helped synthesise medicines used in hospitals, clinics, and other health care centres. Traditional medicine is leading the front-line research for finding a solution to many health challenges which are so common in society. In Nigeria, many diseases were treated and are still being treated with the use of folk medicine, most of which have shown positive results. These diseases include pains, muscle inflammation, ulcers, convulsions, diarrhoea, bacterial and fungal infections, asthma, malaria, diabetes, and typhoid fever. Some of the numerous medicinal plants already in use in Nigeria are: *Garcinia kola*, which is used for

the treatment of asthma; *Carica Papaya* used for hypertension; *Ocimum basilicum* for typhoid fever; *Senna occidentalis* for skin diseases and *Newbouldia laevis* for pains [3].

These medicinal plants' efficacy is based primarily on their diverse phytochemical constituents. Plants contain an array of phytochemicals certified to be pharmacologically active and have been mostly utilised in treating many diseases wrecking both man and animals.

The author [4] stated that a significantly greater area of Nigeria's ecological zones is made up of numerous plant species, which have found their usefulness in the healthcare of the populace. According to [5], the medicinal uses of most of these plants are numerous. They cannot be exhausted in respect of oral traditions and folklores from time immemorial that have continued to increase the medicinal potencies of these plants and their crude extracts. He further stated that there are different bioactive properties embedded in medicinal plants, such as flavonoids, alkaloids, tannins, saponins, glycosides, etc. These bioactive properties obtainable from a wide range of pharmaceutically derived medications consist of components obtained from plants' phytochemicals. The bioactive properties in medicinal plants possess the healing property attributed to such plants [6].

The medicinal plant's secondary metabolites are believed to be intermediates in metabolic processes found in nature and are usually small molecules. Primary metabolites are involved directly in average growth, development and reproduction, for example, (ethanol, acetic acid, citric acid, lactic acid) and cell components (lipids, vitamins and polysaccharides). Secondary metabolites on their own are not directly involved in those processes and usually have a duty not crucial for the organisms, e.g. antibiotics, proteins and carotenoids.

One of such medicinal plants abundant in nature is *Newbouldia laevis* P.Beauv (*Bignoniaceae*). The plant is known to possess great potency in treating *elephantiasis*, *syphilis*, rheumatic swellings, and as a vermifuge to roundworms. The plant has also been identified to help treat sore feet, ear ache, chest pain, children's convulsion and epilepsy [1]. Many ethnic medicinal activities have been reported to be associated with *Newbouldia laevis* leaves extract, such as uterine stimulants, treatment of

arthritis and rheumatism, gastro-intestinal treatment and all kinds of body pain [7].

Investigations from [8] revealed that some phytochemicals are embedded in *Newbouldia laevis*. The leaves of *Newbouldia laevis* P.Beauv are used in folk medicine to treat various ailments like body pain, rheumatism, arthritis, inflammations and others. The crude extract has been found potent in some diseases. This is why the decoction of the leaves is consumed locally as a remedy to many health challenges. There are essential drugs isolated from *Newbouldia laevis* leaves, such as digoxin and digitoxin, which help treat congestive heart failure [9]. Taxol is another drug extracted from the plant. Taxol is used as a cancer chemotherapeutic drug [10]. Newbouldine is another drug for pain relief and antimalarial. Also, lysergic is a drug produced from ursolic acid obtained from *Newbouldia laevis* [11]. Similar research by [12] states that phytochemicals are chemical substances found naturally in plants. Some of these phytochemicals are responsible for colour and organoleptic properties, such as the deep purple of blueberries and the smell of garlic. In contrast, many others are responsible for protecting fruits, plants, vegetables, cereals, beans, and plant-based beverages like tea and wine. Phytochemical screening of the methanolic extract showed the presence of flavonoids, tannins, glycosides, alkaloids, terpenes and steroids [8, 13].

Research done recently by [14] revealed that the leaf crude methanol extract using white whisker albino rats showed no toxic effect at $LD_{50} > 6000$ mg/kg. The researcher conducted similar research on the same laboratory animals. The plant was found to be a very active analgesic at all concentrations and doses. Despite a lot of research in human medicine, challenges are still encountered. One of these leading challenges is body pain, which arises from other ailments and symptoms of a particular sickness. The effect of such medicinal disease conditions is prevalent in Nigeria due to the relative unavailability of medicines with promising efficacy and the proliferation of adulterated analgesic drugs [1].

This research mainly focused on the extraction of the bioactive properties of *Newbouldia laevis*, the study of its structures and the evaluation of their analgesic efficacy in some laboratory animals.

MATERIALS AND METHODS

Extraction. A solvent distillation machine (PS/1598) was used to distil the solvents, and big glass containers were used for cold maceration.

Toxicity Test. Feeder (gavage), cage (Hamster), plates/spoons, weighing balance, string and experimental animals (white albino rats) were used.

Analgesic Test. Weighing balance, string and white albino rats (experimental animals) were used.

Collection and preparation of plant material. The leaves of the plant *Newbouldia laevis* were collected at Amede, Eha-Amufu, Enugu State, on 8th November 2019. Foresters confirmed the leaves at the College of Natural Resources and Environmental Management, Michael Okpara University of Agriculture, Umudike, Abia State. The Herbarium Number was identified as Dar-amola FHI 35500.

The leaves were properly washed and air dried. It was further grounded into powder, weighed and was found to be 800 g. It was soaked with distilled methanol, and after two weeks, it was filtered, and the filtrate was refluxed. Thus the solvent was recovered. The crude methanol extract was then kept to air dry. After one week, it was weighed and found to be 120.191 g. It was thus labelled MCNL.

After the fresh leaves of *Newbouldia laevis* were collected and identified, it was washed, chopped and dried under shade. The dried leaves were thus pulverised to give 800 g. The 800 g was put in a big glass container, and 100 % of methanol was poured into the container to the brim. The container was thus covered and kept. After two weeks, the sample was filtered, the filtrate was refluxed, and the crude extract was kept to dry.

The residue was resoaked again in 100 % methanol, and one week later, it was filtered, and the filtrate was refluxed. Thus, the crude extract was left to air dry. The dried crude extract was weighed to give 120.191 g. It was therefore labelled *Newbouldia laevis* crude methanol (NLCM).

This method of extraction is called cold maceration. The NLCM obtained was used for bioassay, phytochemical screening and fractionation.

The NLCM 120.191 g was thus partitioned via coarse chromatography to give different fractions as NLH – 0.1 g, NLD – 2.5 g, NLE – 4.6 g, and NLM – 10.0 g.

Phytochemical screening. The phytochemical screening of the NLCM was done according to standard methods. Thus, the phytochemical analysis is as follows:

Test for Alkaloids. This was done according to [15]. About 5 g of the sample was weighed into a 250 ml beaker, and 200 ml of 10 % acetic in ethanol was added. It was covered and allowed to stand for 2 hours. This was thus filtered, and the extract was concentrated to $\frac{1}{4}$ of the original volume in a water bath. Concentration $\text{NH}_{3(\text{aq})}$ was then added dropwise till a precipitate was formed. The deposit was collected and washed with dil. $\text{NH}_{3(\text{aq})}$ and filtered. The residue was dried and weighed, and calculated as:

$$\% \text{ Alkaloid} = \frac{W_1 - W_2}{W_i \text{ of sample}} \times 100. \quad (1)$$

Test for Flavonoids. The test was by [15], 5 g of the sample was boiled in 50 ml of 2mHCL solution for 30 min under reflux. It was allowed to cool and then filtered. A measured volume of NLCM extract was treated with equal ethylacetate starting with a drop. The solution was filtered into a weighed crucible. The filtrate was heated to dryness in an oven at 60 °C. The dried crucible was weighed again, and the difference in the weight gave the quantity of flavonoid and calculated as:

$$\% \text{ Flavonoid} = \frac{W_i \text{ of dried extract}}{W_i \text{ of sample}} \times 100. \quad (2)$$

Test for Saponins. The method adopted for this test is according to [16]. 100 cm³ of 20 % aqueous methanol was added to a conical flask. The mixture was heated over a water bath for 4 hours. It was stirred at 55 °C. The residue of the mixture was re-extracted with another 100 cm³ of 20 % aqueous methanol after filtration and heated for 4 hours at a temperature of 55 °C with constant stirring. The combined extract was evaporated to 40 cm³ over a water bath at 90 °C. 20 cm³ of diethylether was added to the concentrated solution in a 250 cm³ separator funnel and vigorously agitated from

which the aqueous layer was recovered while the ether layer was discarded. This was repeated twice. 60 cm³ of n-butanol was added and extracted twice with 10 cm³ of 5 % NaCl. After discarding the NaCl layer, the remaining solution was heated in a water bath for 30 minutes. The answer was transferred into a crucible and was dried in an oven to a constant weight. It was calculated as:

$$\% \text{ Saponin} = \frac{W_i \text{ of Saponin}}{W_i \text{ of sample}} \times 100. \quad (3)$$

Test for Tannins. Tannins were determined via a method by [17]. 1 ml of the sample extract of concentration 1 mg/ml was taken in a test tube. The volume was made up to 1 ml with distilled water, and 1 ml served as the blank to 0.5 ml of Folin's phenol reagent (1:2), followed by 5 ml of 35 % Na₂CO₃ added and kept at 25 °C for 5 minutes. A blue colour was formed, and the colour intensity was read at 640 nm. The tannin was determined and calculated as:

$$\% \text{ Tannin} = \frac{AT \times VF \times DFX}{AS \times VE \times WS} \times 100, \quad (4)$$

where *AT* – Absorbance of tannin solution; *AS* – Absorbance of sample solution; *VF* – Total volume of filtrate; *VE* – Volume of extract analysed; *DF* – Dilution factor; *WS* – Sample weight.

Test for Terpenoids. The method adopted here is from [18]. Dried plant leaves extract 100 mg (*W_i*) was taken and soaked in 9 ml of ethanol for 24 hours. The extract after filtration was extracted by 10 ml of petroleum ether using a separating funnel. The quote was thus separated in pre-weighed glass vials and waited for its complete drying (*W_f*). Ether was evaporated, and the formula measured the yield (%) of total terpenoids content:

$$\% \text{ Terpenoids} = \frac{W_i - W_f}{W_i} \times 100. \quad (5)$$

Test for Cardiac Glycosides. The method recommended by [16]. 22.5 g of the dried sample was weighed into a 250 cm³ flask, and about 200 cm³ of distilled water was added to 1g of each dry wood powder sample and allowed to

stand for 2 hours for autolysis to occur. Full distillation was carried out in a 250 cm³ conical flask containing 20 cm³ of 2.5 % NaOH in the sample after adding an antifoaming agent (tannic acid), cardiac glycosides (100 cm³), 8 cm³ of 6 M NH₄OH and two cm³ of 5 % KI were added to the distillate(s), mixed, and titrated with 0.02 M AgNO₃ using a micro burette against a black background. Continuous turbidity indicates the endpoint. Cardiac glycosides were calculated as:

$$\% \text{ Cardiac glycosides} = \frac{\text{Titre value (cm}^3\text{)} \times 1.08 \times \text{Extract value}}{\text{Aliquot volume (cm}^3\text{)} \times \text{Sample } W_i \text{ (g)}} \times 100 \quad (6)$$

Toxicity Test. Animal stock: The experimental animal used was 18 adult white whisker albino rats of mixed sex. The rats were obtained from an animal house in the College of Veterinary Medicine, Michael Okpara University of Agriculture Umudike, Abia State. The rats were starved of food and water for 24 hours inside a rate cage. The method used for the acute toxicity test (LD₅₀) was according to [19].

Method for Acute Toxicity (LD₅₀) Study of The Extract. About 1.6 g of the crude methanol extract was used for the acute toxicity test. Eighteen adult white whisker albino rats were used. The rats were divided into six groups of 3 rats each, with each group used in a separate cage.

Group 1 was administered 1000 mg/kg body weight of the extract, while groups 2, 3, 4, 5 and 6 were administered 2000, 3000, 4000, 5000 and 600 mg/kg body weight of the animals, respectively. All treatments were done via the oral route using oral gavage, and animals used for the experiment were handled by the OECD rules for care and use of laboratory animals [20]. After the administration, the rats were returned to top cages. They were allowed free access to feed and water and, at the same time, monitored for the development of toxicity signs and mortalities within 24 hours of treatment and an additional seven days. At the end of the period, LD₅₀ values for the extract were determined according to Kaber's formula:

$$L_{D50} = L_{D100} - \frac{\sum DDXMD}{N}; \quad (7)$$

LD₅₀ > 600 mg/kg

Analgesic Test. The method employed for the analgesic test of the crude methanol extract and fractions was according to [21].

Fourteen adult white whisker albino rats were used. The rats were divided into seven groups of 2 rats each, with each group housed in a separate cage. The body weight of each group was taken. Group 1, the control group, were thus given a dose of (1000 mg/kg) of a standard drug (aspirin). The analgesic activity was evaluated by observing the number of writhes they made in 30 minutes. Lower doses of (400 mg/kg) of crude methanol and methanol n-hexane extracts were given in Vivo to groups 2, 3, 4, 5, 6 and 7, respectively, and the number of writhes the rats made in 30 minutes were observed for the analgesic activity and calculated through mean \pm SEM. Also, higher doses of (800 mg/kg) of the crude methanol, methanol, dichloromethane, ethylacetate and n-hexane extracts were given in Vivo to groups 2, 3, and 4, 5, 6 and 7, respectively. The number of writhes the rats made in 30 minutes was observed for the analgesic activities of each extract, which was calculated via mean \pm SEM.

The volume (ml) of the extracts administered to the rats were calculated:

$$V_{ia} = \frac{Dose \times Average\ body\ weight}{Concentration\ of\ extract} \times 100. \quad (8)$$

RESULTS AND DISCUSSION

The extracts NLM, NLE, and NLDCM obtained were used to conduct chemical analysis viz: phytochemical screening, column chromatography, thin layer chromatography, and NMR spectroscopy (Table 1).

Also, a toxicity test was carried out on the crude extract to evaluate if it is toxic or edible. The analgesic test was equally done on the natural extract to examine its analgesic activity on laboratory animals.

Table 1 – The extracts NLM, NLE and NLDCM with their yields and appearance

Extract	Yield (%)	Appearance
NLM	10.0	Reddish brown
NLE	4.6	Greenish yellow
NLDCM	2.5	Dark green
NLH	0.1	Yellow

The quantitative phytochemical screening of methanol crude extract in Table 2 shows that NLCM contains 21.73 ± 0.36 % alkaloids, 40.78 ± 0.27 % flavonoids, 15.99 ± 0.04 % saponins, 6.088 ± 0.06 % tannins, 7.086 ± 0.03 % terpenoids, 0.00 ± 0.01 % steroids, 12.13 ± 0.01 % Cardiac Glycosides.

Table 2 – Results of qualitative and quantitative phytochemical screening of methanol crude extract of *Newbouldia laevis* leaves

Phytochemicals Present		Mean \pm SEM (%)
Alkaloids	++	21.73 ± 0.36
Flavonoids	++	40.78 ± 0.27
Saponins	++	15.99 ± 0.04
Tannins	+	6.088 ± 0.06
Terpenoids	+	7.086 ± 0.03
Steroids	-	0.00 ± 0.01
Cardiac Glycosides	+	12.13 ± 0.01

Alkaloids possess a lot of pharmacological and therapeutic potentials such as analgesic, antihyperglycemic, anticancer, anti-inflammatory, anti-diarrhoeal, etc. Many alkaloids are used as bitter supplements to stimulate the digestive system Bruneton [5].

Also, alkaloids in foods and supplements help improve immune activities, nervous systems and physical performance, as reported by [22]. *Newbouldia laevis*, rich in alkaloids, can be used to prevent and treat infections and relieve pains from arthritis, inflammations, rheumatism and others. The use of *Newbouldia laevis* leaves in traditional herbal medicine as an analgesic, uterine stimulant, antimalarial, and anticonvulsant may be attributed to its high amount of alkaloids.

Flavonoids possess antibacterial, anti-inflammatory, anti-allergic and antiviral activity [23]. Many observed effects have been linked to their known functions as potent antioxidants, free radical scavengers and metal chelators [24]. Foods rich in flavonoids help fight against cancer, stroke, and obesity and lower blood pressure in hypertensive patients [25].

The high occurrence of flavonoid [40.78 ± 0.27] in the NLCM implies that *Newbouldia laevis* leaves an excellent pain killer, anti-inflammatory, anticancer, antioxidant, antihyperglycaemic and other pharmacological activities attributed to *Newbouldia laevis* leaves.

Saponins were also present in the NLCM extract of *Newbouldia laevis* leaves. Saponins have broader applications in beverages, food ingredients and cosmetics. Reports reveal that saponins are an excellent antioxidant, anti-inflammatory, anti-allergic, anticancer, antiviral and antifungal [26–32].

Also, Saponins possess anti-hypercholesterolemia activity. Hypercholesterolemia is implicated in cardiovascular diseases [33]. This implies that consumption of *Newbouldia laevis* decoction may help prevent and reduce the risk of cardiovascular diseases.

Tannins are used in traditional herbal medicine to precipitate proteins. It also possesses pharmacological activities such as antidiarrheal, anti-inflammatory and wound healing [34]. Tannins are a class of compounds found in the leaves of *Newbouldia laevis*. These polyphenolic compounds are used to relieve fatigue and sore throat immediately. Tannins equally heal burns and stop bleeding [35]. These therapeutic effects of tannins are attributed to the ability of tannins to act as free radical scavengers and to activate antioxidant enzymes [36]. The presence of tannins in *Newbouldia laevis* leaves may be responsible for using the plant in traditional medicine as a pain-killer and for treating rheumatism and arthritis.

Terpenoids are another naturally occurring secondary metabolite found in the leaves of *Newbouldia laevis*, and terpenoids serve as cancer chemotherapy. Other important pharmacological and therapeutic uses of terpenoids are antihyperglycemic, anti-inflammatory, anti-arthritic, antioxidant and antimicrobial. Terpenoids like taxol derivatives (paclitaxel and docetaxel) are good cancer drugs. Also, terpenoids like α and β – amyryns are used in herbal folk medicine as analgesics [37]. Terpenoids present in *Newbouldia laevis* are why the decoction of this plant is consumed as a remedy for body pain.

Cardiac glycosides are a class of compounds present in *Newbouldia laevis* leaves. Cardiac glycosides have the potency to increase the heart's output force and decrease its contraction rate by acting on the cellular Sodium-potassium ATPase [38]. Cardiac glycosides are potent therapies for chronic heart failure, oedema, arrhythmias and complete ventricular rate control in persons with atrial fibrillation; this is why the plant is used in traditional medicine as anti-inflammation.

Table 3 – Acute toxicity study of Methanol leave extract of *Newbouldia laevis* LD₅₀ result of the extract

Groups	Dose administered (mg/kg)	No of deaths	Dose difference (DD)	Mean death (MD)	DD × MD
1	1000	0	500	0	0
2	2000	0	1000	0	0
3	3000	0	1000	0	0
4	4000	0	1000	0	0
5	5000	0	1000	0	0
6	6000	0	-	-	-

The LD₅₀ value is determined according to Karbar's formula, which states that:

$$LD_{50} = LD_{100} - \frac{\sum DD \times MD}{N} \quad (9)$$

LD₅₀ > 6000 mg/kg.

Results of the acute toxicity study showed that no death was observed in all test groups administered the extract at all dose levels. The animals instead retained their agility and were physically active throughout the period. The rats helped the highest dose (6000 mg/kg), though they appeared calm immediately after administration of the extract and soon regained their physical activities within a short time. These results are presented in Table 3 above. This finding is by [14], which showed no toxic effect when white whisker rats were treated with leaf crude methanol extract of *Newbouldia laevis*.

Treatment with the crude extract and fractions significantly inhibited acetic acid-induced pain in the experimental rats compared with control (P<0.05). While in the control group, the number of writhes made in 30 minutes was 30.00±5.33 and represented 0 % percentage inhibition of pain, the group treated with aspirin made 8.80±1.02 writhes, representing 64.20±9.74 % inhibition of pain. Percentage inhibitions of pain for 400 mg/kg of crude, methanol, dichloromethane, ethyl acetate and N-hexane extracts were 63.48±4.62, 79.14±7.39, 60.79±6.69, 23.26±9.75 and 64.82±10.14 %, respectively. However, at 800 mg/kg extract treated groups, the inhibitions for the same extracts were 52.00±12.00, 71.87±7.04, 80.31±6.20, 45.61±12.60 and 43.87±8.13 %, respectively. Lower doses of the crude, methanol and N-hexane extracts had better analgesic effects than higher doses. The opposite was in groups treated

with dichloromethane and ethyl acetate extracts. The analgesic activities of the sections also did not significantly differ from that of aspirin ($P>0.05$), except for the ethyl acetate low dose group. From the results obtained, the extract with the highest activity was the methanol extract, while ethyl acetate extract had a minor analgesic activity. The results are presented in Table 4 and Figure 1.

Table 4 – Analgesic Effects of the Crude Methanol Extract and its fractions of the Leaf extracts of *Newboudia laevis* on Whisker Albino Rat

Groups	Treatment Dose Administered	Number of Writhes in 30 min	% Activity of the Extracts
1	Control	30.00 ± 5.33**	0.00 ± 0.00**
2	Aspirin AS (100mg/kg)	8.80 ± 1.02*	64.20 ± 9.74*
3	Crude methanol extract NLCM (400 mg/kg)	10.00 ± 0.89*	63.48 ± 4.62*
4	Crude methanol extract NLCM (800 mg/kg)	12.00 ± 0.89*	52.00 ± 12.00*
5	Methanol extract NLM (400 mg/kg)	5.60 ± 1.94*	79.14 ± 7.39*
6	Methanol extract NLM (800 mg/kg)	8.40 ± 2.48*	71.87 ± 7.04*
7	Dichloromethane extract NLD (400 mg/kg)	14.00 ± 2.28*	60.79 ± 6.69*
8	Dichloromethane extract NLD (800 mg/kg)	6.00 ± 2.28*	80.31 ± 6.20*
9	Ethyl acetate extract NLE (400 mg/kg)	24.00 ± 4.56**	23.26 ± 9.75**
10	Ethyl acetate extract NLE (800 mg/kg)	17.20 ± 2.73**	45.61 ± 12.60*
11	n-hexane extract NLH (400 mg/kg)	8.60 ± 1.33*	64.82 ± 10.14*
12	n-hexane extract NLH (800 mg/kg)	17.60 ± 2.40**	43.87 ± 8.13*

Results are expressed in Mean±SEM. Means marked * are significantly different from control, while that marked ** are substantially different from aspirin.

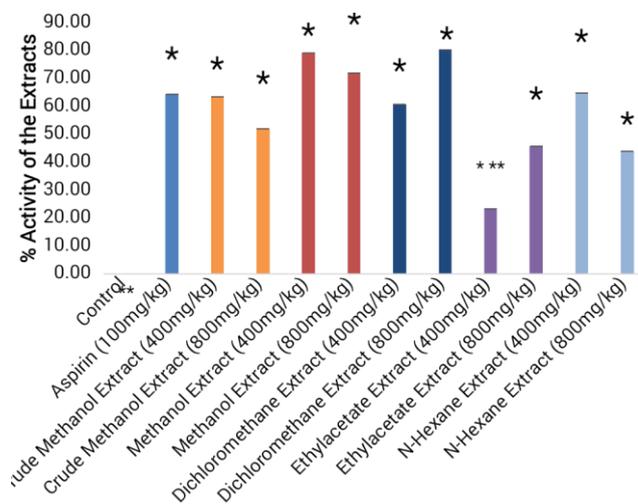


Figure 1 – The percentage analgesic activities of different doses of the extracts

CONCLUSIONS

The results obtained from phytochemical screening, toxicity test and the analgesic test was done on the NLM, NLDCM, and NLHEX extracts from the leaves of *Newbouldia laevis* gave the following findings: phytochemical screening revealed the presence of the following phytochemicals; alkaloids, flavonoids, Saponins, Tannins, Terpenoids and cardiac glycosides. The acute toxicity test showed that test groups administered the extract at all doses. The result of the analgesic test showed that methanol extract exhibited the highest inhibition of pain at lower doses of 400 mg/kg body weight of the laboratory animals. In contrast, the ethylacetate extract had minor analgesic activity at the same dose with methanol. From these results and the various analyses done on the leaf extracts of *Newbouldia laevis*, it is evident that this plant contains bioactive components that can be used to treat multiple health problems such as pain, inflammation, and oedema, rheumatism and arthritis and heartburn. Thus, it can be said that these research work aims have been achieved.

From the results obtained in this research, people are encouraged to use the leaves of *Newbouldia laevis* to treat pains. Pharmaceutical industries should immediately start using the extracts from this plant to produce more potent (pain killer) drugs that will have fewer side effects than Ibumol, Ibuprofen, Diclofenac, et cetera.

The government should enact laws to conserve shrubs, subshrubs and trees like *Newbouldia laevis* to maintain their abundance for various uses. People in different places should embrace the ethnomedicinal services of the plant *Newbouldia laevis* in order to obtain the medicinal benefits embedded in the plant.

This research on the leaf extract of *Newbouldia laevis* shows that people can use it to treat pains. The leaf extract of *Newbouldia laevis* is efficient, non-toxic, potent and reliable for treating body pain. This finding will go a long way in helping further research work on the leaf of *Newbouldia laevis*.

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Comparative Studies of the Clarification Potentials of Ferric Chloride and *Moringa Oleifera* Coagulants

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Abstract. The significant treatment costs of drinking water make treated water costly, raising the price of clean and helping make clean water inaccessible to the poor people in rural communities. This compels them to turn to readily available sources which are mainly contaminated. This subjects them to waterborne diseases.

In this context, this study was carried out to validate the efficiency and, if feasible, the substitution of Ferric Chloride utilised in the treatment of water using *Moringa Oleifera* seeds, a cheap and widely accessible indigenous coagulant. The quality of water was tested on collection compared to those treated with Ferric Chloride and Moringa Seeds. Doses of 5 g, 10 g, 15 g, 20 g, 25 g and 30 g of both coagulants were used to treat 500 ml of water. Control water without Ferric Chloride and Moringa treatments was included. The pH, turbidity, conductivity and COD were measured. From the ANOVA statistical analysis, several factors such as pH were analysed, and there was a wide variation between the two treatments of Moringa and Ferric Chloride.

Keywords: *Moringa Oleifera*, Ferric Chloride, water treatment, Coagulants, Turbidity.

INTRODUCTION

Potable water supply is a significant endeavour, particularly in underdeveloped nations. This is so because the chemicals necessary for treatment: alum for coagulation, polyelectrolytes as coagulant aids, lime for softening and pH correction, and chlorine for disinfection; have to be imported using limited foreign currency. In reply to this, local resources are being investigated as an alternative.

Various academics have investigated *Moringa Oleifera* seeds in this respect. Among all the plant materials which have been evaluated throughout the years. The sources from *Moringa Oleifera* have indeed been found to be one of the most efficient as the main coagulant for water treatment.

In this Minor field Observation, we will examine the possibility of using Moringa as an alternative water clarification agent for water treatment in Umudike and establish a protocol for the prepa-

ration, use and dosage of Moringa to use it for water treatment.

Water is a crucial natural resource needed for maintaining life. It is in a continuous circulation movement (i.e., hydrological cycle) and is not equally distributed in time and location. Due to its various advantages and the challenges generated by its surpluses, shortages and quality degradation, water as a limited resource demands particular care.

Water treatment generally incorporates water clarity and disinfection techniques [11]. In traditional water treatment, several procedures comprising coagulation, flocculation, sedimentation, filtration and disinfection are typically utilised [6]. A combination of numerous methods is frequently required to enhance raw water quality depending on the water quality issues present, the desired quality of the treated water, the costs of different treatments and the scale of the water system [4].

Methods of water treatment from biological materials will undoubtedly be successful in delivering water at a low and reasonable price and at all times in every home. One strategy that has been performed by people in some areas of the developing world is using locally available natural coagulants to lower turbidity and decrease bacteria in surface water [1].

Lack of safe drinking water is the world's most significant health issue. About 4 billion instances of diarrhoea are recorded yearly, of which two million result in death. Every day roughly 6 thousand children die from lack of safe drinking water. Today, more than one billion people in developing nations use polluted water for drinking and other domestic purposes. Moringa is recognised as the solution to lower the prevalence of water-related infections, which is one of the leading causes of fatalities in developing countries. United Nations has set Millennium Development Goals (MDG's), aiming to eliminate half the number of people without access to clean water by 2020. The aim can be accomplished only through the utilisation of locally available resources and by the adoption of low-cost treatment options.

The study aims to carry out comparative studies of the clarification potentials of Ferric Chloride and *Moringa Oleifera* coagulants. In this research, we seek to compare the water clarification potentials of these two coagulants to identify which is more effective for water clarification. These objectives can be achieved through the completion of the following steps. They are mixing different dosages of the coagulants with the effluent to determine their different rates of clarification.

There are various kinds of Natural Coagulants, but this research is restricted solely to studying *Moringa Oleifera* and comparing its Clarification capability to that of Ferric Chloride.

Although water treatment chemicals are efficient and utilised globally, research data reveals that exposure to chemicals during coagulation with metal salts might be connected with detrimental health consequences [6]. Aluminium, which is the primary component of Aluminium Sulphate (alum), Polyaluminium chloride (PAC) and Polyaluminium Silica Sulphate (PASS), might cause Alzheimer's disease and other similar connected disorders that are associated with residual Aluminium in treated water [4]. The use of natural materials to purify drinking water in various places around the globe has been documented throughout human history. However, these natural materials have not been accepted or appro-

priately supported owing to a lack of understanding of their specific nature and the mechanism by which they work. As a result, the natural materials cannot compete successfully with the regularly utilised water chemicals [9, 10].

There has been a renewed interest in using naturally occurring alternatives to currently used coagulants for water treatment in developing countries [3], mainly due to cost implications linked with inorganic chemicals, synthetic organic polymers and disinfectants [9, 10]. There is also an interest in utilising some of the by-products from natural coagulants in other industries [5].

The conclusions of this research will be valuable to stakeholders in the academic and environmental sectors. These stakeholders comprise healthcare personnel, government health authorities, teachers and students if *Moringa Oleifera* is proven more efficient than ferric chloride as a clarifying agent. Findings from this study might give information which could enlighten the government on the necessity for workshops, seminars and conferences to extend the knowledge on the usage of Moringa and the search for Natural alternative sources of Coagulants to be integrated into the water treatment process in the Country.

METHODS

Preparation of Coagulants. *Moringa Oleifera*: The seeds of Moringa will be collected/sourced from a National Root Crops Research Institute. They would be air-dried at 45 °C for 48 hours. The chaff around the seed kernel will be separated, and the grains will be crushed fine using a blender into powder. This was how the *Moringa Oleifera* coagulants would be made.

Ferric Chloride: Ferric Chloride would be obtained from a science laboratory in Umuahia Township. It will also be packaged and sealed on purchase.

Preparation of Effluent. To carry out the preliminary studies to determine the efficiency of these coagulants, we sourced water from a local stream from stream located along Goodluck Ebele Jonathan Hostel in Michael Okpara University of Agriculture, Umudike.

Apparatus: pH Meter – for measuring pH Level; spectrophotometer – for determination of COD; conductivity Meter – measuring conductivity; turbidimeter– for turbidity measurements; jars

and beakers; pipettes; measuring cylinders; weighing balance; stopwatch; oven.

Analysis. The jar test is the most often used technique for analysing and optimising the coagulation-flocculation processes. This research consists of a series of simultaneous batch tests, including three steps: quick mixing, gradual mixing, and sedimentation.

Turbidity measurements were made using a turbidimeter. Turbidimeter will be measured using distilled water, and 40 NTU standard solution will be made using 1 g hydrazine and 10 gm hexamethylenetetramine solution. The pH will be adjusted using concentrated Sulphuric acid 0.1 M and sodium hydroxide 0.1 M solution. The pH will be tested using a pH meter.

Conductivity will be determined using a conductivity meter. For estimation of COD, the effluents will be digested in the spectrophotometer, and the titration will be carried out using the standard reagents and technique.

RESULTS AND DISCUSSION

The volume of water at the beginning of the test was 6.5 litres, divided into 12 jars of 500 ml for treatment and an additional pot for control.

The values of the different test parameters for the water at the point of collection (serving as our control) are as follows (Table 1).

Table 1 – The values of the different test parameters for the water

Parameters	Initial values of stream water sample (control)	WHO standard
pH	5.7	7.6
Conductivity ($\mu\text{s}/\text{cm}$)	107	1400
Turbidity (NTU)	7.9	5
COD (mg/L)	6.9	100

Value of POC against WHO standard. The results obtained from the following treatments for these parameters would be tested against the WHO standard for drinking water, and the better coagulant would be selected.

Physicochemical Measurements. The mean values of physicochemical parameters for raw water samples such as pH, Conductivity, Turbidity and Chemical Oxygen Demand before and after treatment with different dosages of the coagulants.

The World Health Organization considers normal drinking water any water with a pH between 6.5 and 8.5 [13]. Although pH typically has little direct influence on water users, it is one of the essential water-quality criteria.

Moringa Oleifera's coagulant efficiency resides in the presence of water-soluble cationic proteins in the seeds. This means that in water, the essential amino acids contained in the protein of *Moringa* would absorb a proton from water triggering the release of a hydroxyl group [9, 10]. In similar research, [8] discovered that pH did not significantly influence the quality of treated water in a randomised factorial experiment with varying quantities of *Moringa Oleifera*.

The pH of water during treatment is critical for removing organic compounds and heavy metals. Alkaline pH encourages the precipitation of most metals as insoluble solids. The pH of the residential sewage at the time of collection was 5.7. After treatment, the pH value declined and ranged from 3.6 to 4.2 for Ferric Chloride and *Moringa Oleifera*. The matter went from 4.5 to 4.7. The reported pH levels were not within the WHO suggested limit of pH of 8.5 to 6.5 for chemically treated water [13], rendering them unsafe for drinking. The differences were significant ($p < 0.05$) between all the treatments at the varied coagulant concentrations on pH. These pH readings do not fall inside the WHO criteria for drinking water. Both Coagulants, however, lowered the pH of the water to acidic levels (Table 2).

Table 2 – Values of laboratory tests conducted on water samples

Ferric chloride					Moringa				
Dosages, g	pH	Turb (NTU)	Cond ($\mu\text{s}/\text{cm}$)	COD (mg/l)	Dosages, g	pH	Turb (NTU)	Cond ($\mu\text{s}/\text{cm}$)	COD (mg/l)
5	3.6	8.5	534	8.11	5	4.5	11.7	250	7.82
10	3.8	8.6	538	8.32	10	4.3	12.0	258	8.10
15	3.9	8.9	542	9.55	15	4.4	12.8	260	8.22
20	4.0	9.2	553	10.25	20	4.3	13.0	264	8.35
25	4.1	9.7	558	11.03	25	4.6	13.4	269	8.51
30	4.2	10.5	565	12.26	30	4.7	13.7	273	8.70

The figure 1 suggests a steady rise in the pH of the water sample with a matching increase in the doses of both *Moringa Oleifera* and Ferric Chloride. From the ANOVA statistical analysis, there

was an evident significant difference between the two treatments of Moringa and Ferric Chloride ($P=6.98 \times 10^{-4}$) (Figure 2).

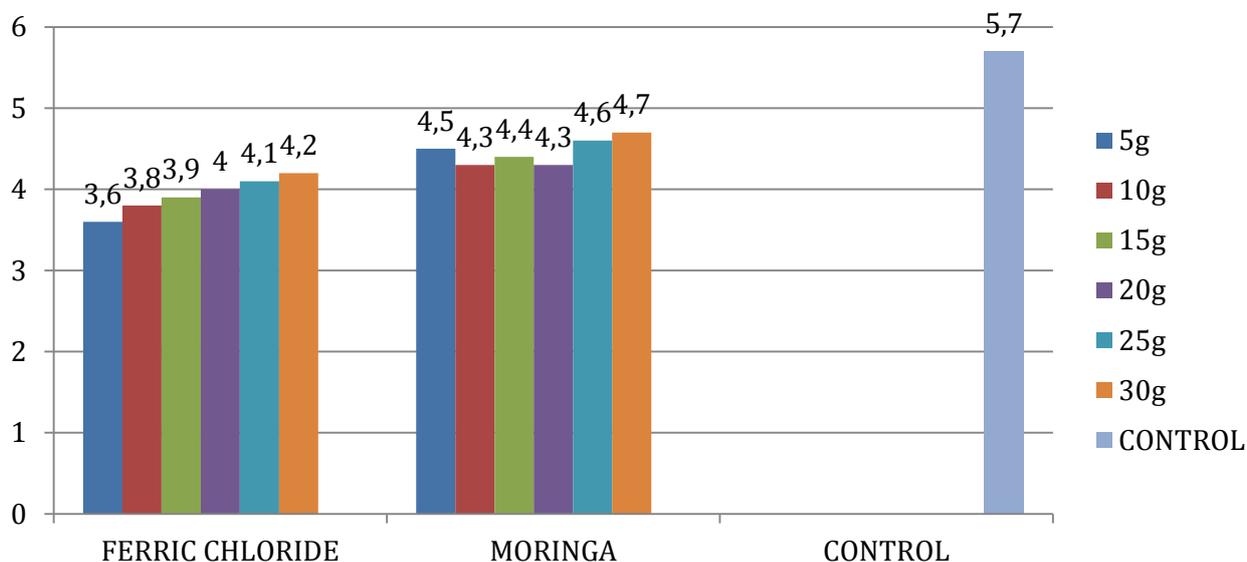


Figure 1 –Effect of different doses of coagulants on water sample wrt ph

Anova: Single Factor						
SUMMARY						
Groups	Count	Sum	Average	Variance		
Column 1	6	23.6	3.933333	0.046667		
Column 2	6	26.8	4.466667	0.026667		
ANOVA						
Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	0.853333	1	0.853333	23.27273	0.000698	4.964603
Within Groups	0.366667	10	0.036667			
Total	1.22	11				

Figure 2 – Anova analysis for Ph of both Moringa and Ferric Chloride

Chemical Oxygen Demand. Chemical oxygen Demand is the measure of oxygen equivalent to the sample’s organic content that is subject to oxidation by a strong chemical oxidant. It is an evaluation used to measure the level of water contamination by organic matter. The COD values for the Stream Water were 6.9 on the collection and moved from 8.11 to 13.26 on treatment with different doses of *Moringa Oleifera* coagulant and

also moved from 7.82 to 8.70 on treatment with varying amounts of Ferric Chloride coagulant.

Figure 3 indicates a gradual increase in the pH of the water sample with a corresponding increase in the dosages of both *Moringa Oleifera* and Ferric Chloride. The ANOVA statistical analysis showed a significant difference between the two treatments of Moringa and Ferric Chloride. ($P=3.36 \times 10^{-2}$) (Figure 4).

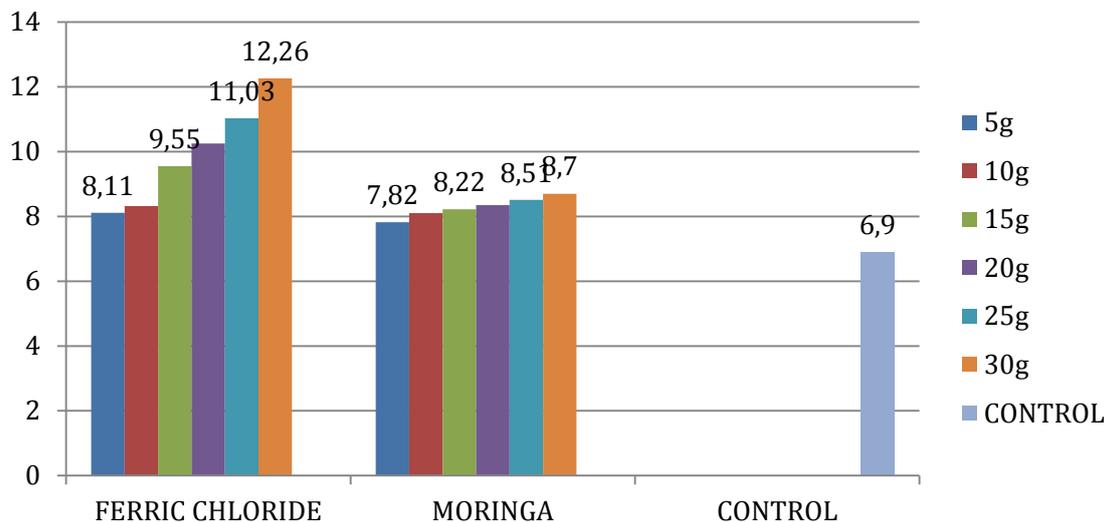


Figure 3 – Effect of different doses of coagulants on water sample wrt COD

Anova: Single Factor						
SUMMARY						
Groups	Count	Sum	Average	Variance		
Column 1	6	59.52	9.92	2.55792		
Column 2	6	49.7	8.283333	0.096347		
ANOVA						
Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	8.036033	1	8.036033	6.055182	0.033635	4.964603
Within Groups	13.27133	10	1.327133			
Total	21.30737	11				

Figure 4 – Anova analysis for COD of both Moringa and Ferric Chloride

Electrical Conductivity. Electrical Conductivity (EC) measures a solution's capacity to conduct electric current, which is significantly reliant on the availability of ionic species. Inorganic ions have a substantial impact on the conductivity of water. High values of EC suggest that inorganic ions are in plenty in the wastewater. EC is directly proportional to the total dissolved solids (TDS) concentration. High EC in wastewater is a sign of high total dissolved solids concentration. This also means that the capacity of an electric current to travel through the wastewater is proportional to the number of ionic solutes dissolved in the water.

Figure 5 suggests a steady rise in the pH of the water sample with a matching increase in the doses of both *Moringa Oleifera* and Ferric Chloride. From the ANOVA statistical analysis, there was an evident significant difference between the two treatments of Moringa and Ferric Chloride. ($P = 2.63 \times 10^{-13}$) (Figure 6).

Turbidity. These turbidity readings obtained following seed coagulation were under the WHO-recommended turbidity threshold of 5 NTU for safe drinking water [13]. Before the water treatment from the Moringa and Ferric Chloride villages, turbidity levels were found to be over the required criteria for drinking water.

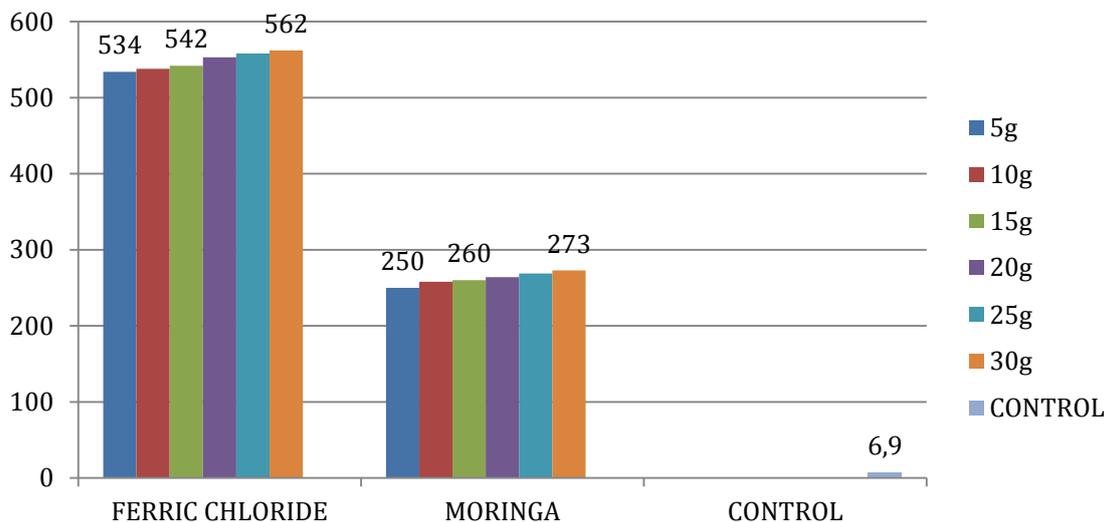


Figure 5 – Effect of different doses of coagulants on water sample wrt conductivity

Anova: Single Factor						
SUMMARY						
Groups	Count	Sum	Average	Variance		
Column 1	6	55.4	9.233333	0.574667		
Column 2	6	76.6	12.76667	0.610667		
ANOVA						
Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	37.45333	1	37.45333	63.1946	1.24E-05	4.964603
Within Groups	5.926667	10	0.592667			
Total	43.38	11				

Figure 6 – Anova analysis for turbidity of both Moringa and Ferric chloride

The turbidity measured might be ascribed to phytoplankton, re-suspended bottom sediments and organic debris. Surface runoffs, features of parent rock and human activities such as farming in the immediate surrounding of water sources also add to the rise of turbidity [13]. Excessive turbidity in water creates issues with the water purification process, such as flocculation and filtration and is usually connected with the likelihood of microbiological contamination [7].

The turbidity at the point of the collection was 7.9 NTU. Figure 7 shows that the turbidity level fell fast for the control culture for both Ferric Chloride and Moringa treatments throughout the experiment.

From the ANOVA statistical analysis, there was an evident significant difference between the two treatments of Moringa and Ferric Chloride ($P=1.24 \times 10^{-5}$) (Figure 8).

CONCLUSIONS

This study focuses on the introduction and adoption of Natural coagulants in water treatment facilities. Artificial coagulant such as Ferric Chloride, tested for clarity against *Moringa Oleifera*, has indicated that Moringa is a good alternative for Artificial Coagulants in treatment plants.

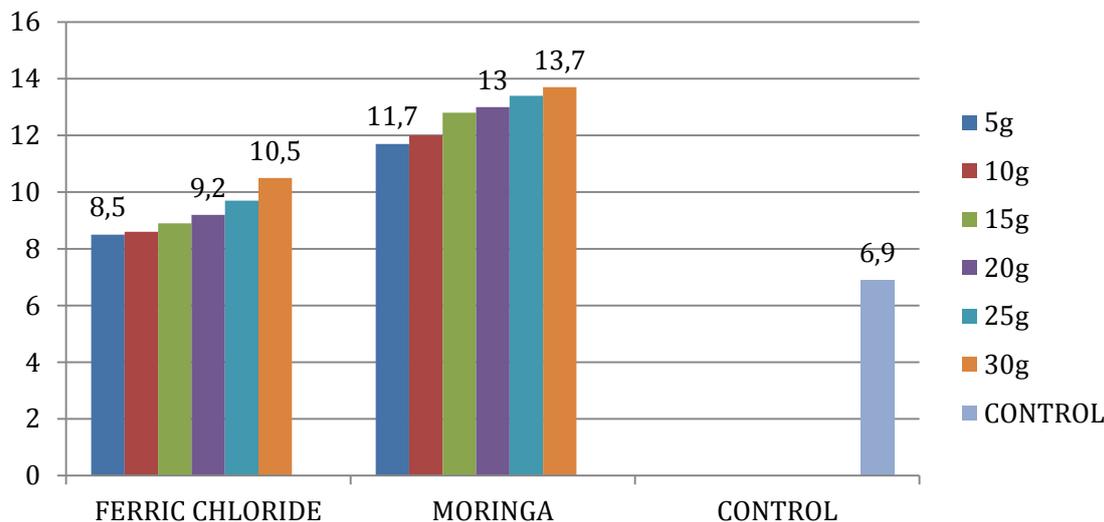


Figure 7 – Effect of different doses of coagulants on water sample wrt turbidity

Anova: Single Factor						
SUMMARY						
Groups	Count	Sum	Average	Variance		
Column 1	6	3287	547.8333	130.5667		
Column 2	6	1574	262.3333	67.46667		
ANOVA						
Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	244530.8	1	244530.8	2469.592	2.63E-13	4.964603
Within Groups	990.1667	10	99.01667			
Total	245520.9	11				

Figure 8 – Anova analysis for the conductivity of both Moringa and Ferric chloride

Moringa Oleifera is an efficient natural coagulant which may be employed in enhancing the physicochemical parameters of water in terms of pH, turbidity, COD and conductivity.

Moringa Oleifera is an ecologically safe natural coagulant best appropriate for treating water with undesired heavy metal concentrations. Based on the experimental test findings, the following conclusions may be drawn:

1. *Moringa Oleifera* is an eco-friendly technology and commercially favourable.
2. *Moringa Oleifera* is an efficient natural coagulant which may be employed in enhancing the

physicochemical features of water in terms of pH, turbidity, total dissolved solids, suspended particles, alkalinity and conductivity.

3. *Moringa Oleifera* seeds provide a feasible alternative coagulant to alum purifying water for rural communities because they are ecologically benign and inexpensive.

4. The data obtained demonstrate that powder from the seed of *M. Oleifera* includes specific coagulating capabilities. These concentrations have the same impact as the traditional coagulum, alum, or Ferric Chloride.

5. *Moringa Oleifera* seeds provide a feasible alternative coagulant to alum purifying water for rural residents because it is ecologically benign and inexpensive.

Based on our results, we may offer the following suggestions. There is a need for public education on the usage of *Moringa* in water clarity via seminars and the media. Also, there is a need for water treatment facilities to integrate organic coagulants into the treatment plants since they are conveniently obtained and medically suitable. Government and commercial groups should en-

gage more in *Moringa* farming as it has the potential to lower the cost of water treatment and may help improve the water quality for rural populations.

A future study is proposed on the following:

- the combination of both Natural and Artificial coagulants in various dosages and a study of their combined efficiency on the wastewater sample.

- timed examination of the long-term state of water treated with *Moringa Oleifera* Coagulant.

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Provenance Studies of Alluvial Tin Deposits in Parts of Ropp Younger Granite Complex, Northcentral Nigeria

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Abstract. The study area in this research is within the Ropp Complex, part of the Nigerian Mesozoic Younger Granite province. The study aims to interpret the depositional environment and establish the provenance of the alluvial cassiterite deposits in the study area. Boreholes/mining pits were logged for this study, and stanniferous sandstone samples were collected, which were used for textural and mineralogical studies. The mineral assemblages documented in the samples include ilmenite (3 to 27%). Cassiterite (2 to 14 %), Zircon (2 to 16%), magnetite (0 to 17%), tourmaline (5 to 11%), rutile (2 to 8%) and monazite (2 to 7%). The ZTR Index calculated from the result of heavy minerals analysis for the selected pieces is 59%. Mineralogical studies revealed that quartz is the most dominant detrital mineral averaging about 93-99%, indicating that the stanniferous sandstones are compositionally matured and have experienced a high degree of chemical weathering. The quartz grains have grain sizes ranging from coarse to very coarse. They are poorly sorted, sub-angular to sub-rounded, with low sphericity. This also indicates a closeness to the source and textural immaturity. The occurrence of relatively very few feldspar grains suggests a slow sedimentation rate, very high rate of chemical weathering and composition maturity. The bivariate plots, univariate grain size parameters and probability plots, and the absence of fossils and trace fossils suggest deposition in a fluvial environment. The results of the granulometric analysis indicate that the study area's stanniferous sandstone was deposited in a fluvial environment by a low-energy fluvial (river) depositional system and the deposition in proximal (close to the source). This study suggests that the Basement complex and Younger Granite are the sources of the stanniferous placer deposits.

Keywords: fluvial environment; heavy mineral; petrography; ropp complex; stanniferous sandstone.

INTRODUCTION

Provenance studies involve the interpretation of the lithologic source of sediments and/or sedimentary rocks [21]. It is one of the key elements of basin analysis, as it provides basic information regarding the tectonic origin of a sedimentary basin using compositional and textural properties of sediments. Information about the source of sediments may be obtained from examining the various clasts present [23, 1]. The most crucial aspect of provenance studies is identifying source rock, relief, the climate in the source area, tectonic settings, transport history and diagenetic

modifications. Provenance studies of sedimentary rocks, especially sandstones, have been carried out by many workers to extract information from compositional and textural features of sandstones, and a thorough review of the subject is given by [24]. Standard petrographical approaches to identifying source rocks of sandstone investigations of undulosity and polycrystallinity of quartz grains, types of feldspar present [23] and rock fragments [24]. The relief and climate of the source area can be inferred from grain roundness and the average degree of feldspar alteration [10]. Tectonic settings can be determined from the relative proportion of quartz,

feldspar and rock fragments [6]. Clues of sandstone's transport history can come from examining the roundness and sphericity of grains and textural and mineralogical maturity [24].

Alluvial tin deposits have been reported in the Younger Granites of mostly North Central Nigeria. [27, 28, 22]. Some of these Younger granite occurrences have also been reported in North-western Nigeria. [14]. The major sources of cassiterite in Nigeria are the placer (alluvial and eluvial) deposits from the biotite granites within the Jurassic alkaline ring complex (the Younger Granites) of the Jos Plateau. Placers are probably one of the earliest types of mineral deposits to have been utilized by man. Author [2] pointed out that the tin placer deposits were rarely treated as serious topics within classical tin geology, even though [4] estimated that 80 % of the world's tin production was derived from placer deposits. The lack of understanding of tin placers may be illustrated by examining the inferred distance of transport of cassiterite from the source rock. According to [8], the median transport distance from bedrock source for economic tin placer deposits is only 8 km. Other undiscovered bedrock mineralization sources were possibly contributing en route, and the dispersion could be even shorter.

Most of the published and unpublished literature on the occurrence of tin in the Younger granite focuses on the primary mineralization of tin; this shows that only a little knowledge is highlighted about the alluvial tin mineralization in the complex even though over 95% of the tin (cassiterite) produced in Nigeria was mined in the Younger Granite Province and were won from alluvial deposits derived from the tin-bearing granites and lodes [15, 16]. The rich and extensive placers of the Jos Plateau were mainly formed from the erosion of the basement rocks. During a period of elevated base level, streams aggraded their valleys and buried the placers beneath a blanket of clay and alluvium.

Study area

The study area is in parts of Ropp Complex, located southeast of the Jos Bukuru Complex in North Central Nigeria. The complex is known for its whitish riebeckite granites, extensive kaolin and tin mineralization, and long mining history. It was the second largest tin producer in the Nigerian Younger Granite Province [3]. The study ar-

ea is situated in Barkin Ladi LGA within latitude 9030'00" to 9015'00"N and longitude 8045'00" to 8052'30"E of the Federal Survey Map sheet 189 Kurra NE (Figure 1).

The study covers an area of approximately 375 km². The area is accessible by tarred roads, untarred roads, footpaths and cattle tracks. The area is marked by high topography averaging about 1350 m above sea level. The complex is bounded by extensive actuate and polygonal ring dykes, which enclose basement rocks and the prominent central massif of rugged younger granite hills.

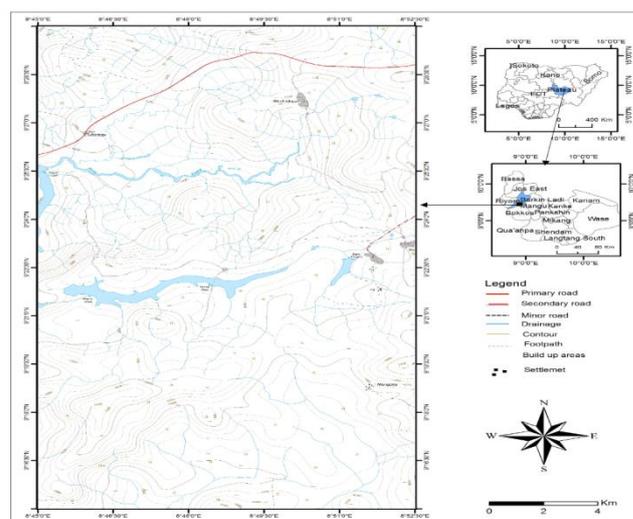


Figure 1 – Location map of the study

The drainage pattern of the area is radial and essentially controlled by the distribution of younger granite outcrops. The central river system in the study area is the River Kurra and its tributaries, draining into Monguna and Tente provinces, where dams are constructed.

MATERIALS AND METHODS

The methods employed in this research work were fieldwork and laboratory analyses. The fieldwork involved description, logging, measurement and sample collection of various lithologic units. Samples were collected for laboratory analyses. The laboratory work involves textural, petrographic and heavy minerals analyses of cassiterite-bearing sandstone samples.

Granulometric analysis. This analysis was used to determine and evaluate the grain size distribution and texture of selected samples of the staniferous sandstones of the study area. Friable

and unconsolidated arenaceous models were the only ones subjected to sieve analysis. The samples were first disintegrated into individual grains using the ceramic mortar and pestle. Each sample was soaked with hydrogen peroxide for about 2-3 hours in a beaker. This is done to aid the disintegration of the samples further to eliminate the effect of cementation.

Each sample was placed in a sieve shaker and sieved for about 10 minutes using standard sieve openings of 2, 1, 0.6, 0.5, 0.3, 0.25, 0.15, and 0.075 mm and pan. The percentage mass retained and cumulative percentage of the group retained for each sample were determined. The methods then computed the statistical parameters (mean, standard deviation, skewness, and kurtosis) of the grain size frequency distribution [12, 18]. A probability scale was used in plotting the standard cumulative curves of grain size distribution following the procedures of [7, 26].

Petrography. Thin-section petrography of the stanniferous sandstones was carried out at the geological laboratories of Ahmadu Bello University Zaria on the ten representative samples for microscopic examination of their mineralogical composition. The samples were impregnated in epoxy before cutting and mounted on glass slides using Canada balsam. The rock slice was glued to a glass slide and was ground to 30 microns thick.

The prepared slides were then labelled and examined with the aid of transmitted light under the flat stage of the petrographic microscope. The studied thin sections were described in terms of grain contacts, roundness, grain size and sorting.

Point counting. Modal analyses of the samples were carried out using Jmicrovision v1.27 Image Analyzer. In each thin section, 300 points were counted to calculate the composition. The objective of point-counting is to identify grain types (framework), cement, matrix and their proportion for each thin section. Classification of the sandstone was determined using [10, 23] methods. Major detrital framework components of the sandstone quartz, feldspar and lithic fragments were used to construct a QFL ternary diagram.

Heavy mineral analysis

The heavy mineral analysis was carried out in the Sedimentology Laboratory of the Department of Geology, Ahmadu Bello University Zaria. The sandstones were sieved to obtain the very fine to

fine sand fractions (4 phi), which are commonly analyzed because it is the size fraction likely to contain the highest percentage of heavy minerals. Two grams from each sample were weighed and poured into the centrifuge tubes containing 10 ml of the heavy liquid (bromoform). The centrifuge tubes were inserted in their respective holes in the centrifuge, and the cover was closed before running the machine for 10 minutes. Acetone was used to clean and deodorize the bromoform in the heavy minerals.

Furthermore, Magnetic separations were carried out to identify opaque heavy minerals. Although the Frantz electromagnetic separator may be used to separate minerals, it is slow. The sample can be contaminated by impurities such as rust and leftover minerals from the previous separation. So, a hand-magnet was used, which was invaluable in telling the difference between magnetite, ilmenite, and other opaque minerals.

Furthermore, the heavy minerals were identified and examined with a binocular microscope. The percentage of heavy minerals in each sample was determined using the Fleet method by counting all the grains in the mount (manually) [9]. Whenever possible, at least 200 heavy minerals were identified and counted from each slide, which is a sufficient number for characterizing the abundances of common species. The "ZTR" index was calculated using the percentage of the combined Zircon, Tourmaline and Rutile grains for each sample according to the formula below.

$$ZTR\ Index = \frac{Zircon + Tourmaline + Rutile}{Total\ No\ of\ Opaque\ Heavy\ Minerals}$$

The calculated index is expressed in percentage to ascertain the mineralogical maturity of the sediment. ZTR <75% implies immature to sub-mature sediments, and ZTR >75% indicates mineralogical matured sediments. Apart from the ZTR index, various frequency percentage plot of both pie charts were made for each sample.

RESULTS AND DISCUSSION

Granulometric analysis

Eleven samples were used for the grain size analysis using standard sieve analysis techniques as outlined in [11].

Grain size statistical parameters. Table 1 shows the calculated values of various grain size parameters: the mean, median, skewness, kurtosis

and standard deviation of the samples. The calculation of the multiple parameters follows [11].

Table 1 – Summary of the Interpretation of the Grain Size Statistical Parameters

Samples	Graphic Mean (Mz)	Graphic Standard Deviation (Sorting)	Graphic Skewness	Graphic Kurtosis
KA2	-0.47 / Very coarse sand	1.94 / Poorly sorted	0.12 / Fine skewed/ positively Skewed	0.94 / Mesokurtic
CHR	0.60 / Coarse sand	1.5 / Poorly sorted	0.15 / Fine skewed/ positively Skewed	0.94 / Mesokurtic
RYM1	-0.27 / Very coarse sand	1.8 / Poorly sorted	0.14 / Fine skewed/ positively Skewed	0.96 / Mesokurtic
GMS 1	-0.08 / Very coarse sand	1.75 / Poorly sorted	0.12 / Fine skewed/ positively Skewed	0.9 / Mesokurtic
RYM2	-0.53 / Very coarse sand	1.98 / Poorly sorted	0.08 / Nearly symmetrical	0.83 / Platykurtic
NGR	-0.13 / Very coarse sand	1.82 / Poorly sorted	0.08 / Nearly symmetrical	0.9 / Mesokurtic
GMS2	-0.13 / Very coarse sand	2.27 / Very Poorly sorted	0.15 / Fine skewed/ positively Skewed	0.86 / Platykurtic
BD2	0.20 / Coarse sand	1.29 / Poorly sorted	-0.01 / Nearly symmetrical	0.8 / Platykurtic
BD1	-0.27 / Very coarse sand	1.8 / Poorly sorted	0.12 / Fine skewed/ positively Skewed	0.91 / Mesokurtic
TNT	-0.40 / Very coarse sand	1.73 / Poorly sorted	0.12 / Fine skewed/ positively Skewed	0.87 / Platykurtic
DG1	-0.03 / Very coarse sand	1.71 / Poorly sorted	0.09 / Nearly symmetrical	0.94 / Mesokurtic

Table 2 – Result Showing Percentile Distribution of all Samples

Samples	KA2	CHR	RYM1	GMS 1	RYM2	NGR	GMS2	BD2	BD1	TNT	DG1
Φ5	-3	-1.4	-2.7	-2.3	-3.1	-2.5	-3.1	-1.8	-2.6	-2.5	-2.2
Φ16	-2.4	-0.9	-2.1	-1.85	-2.6	-2	-2.5	-1.2	-2.1	-2.2	-1.8
Φ25	-1.8	-0.6	-1.6	-1.4	-2.1	-1.5	-1.9	-0.8	-1.6	-1.6	-1.2
Φ50	-0.5	0.5	-0.4	-0.1	-0.5	-0.1	-0.3	0.2	-0.3	-0.4	0
Φ75	1.0	1.5	0.8	1.2	1.0	1.2	1.4	1.2	1.0	1.0	1.2
Φ84	1.5	2.2	1.7	1.7	1.5	1.7	2.4	1.6	1.6	1.4	1.7
Φ95	3.4	3.4	2.9	3.4	3.2	3.4	3.8	2.1	3.2	3	3.3

Graphic mean (MZ). The graphic mean value for the samples ranges from -0.03 to 0.20 Φ (Table 1), i.e. from very coarse-grained to coarse-grained sandstones. The explicit mean values of all the samples indicate the predominance of very coarse-grained sandstone (10 samples), followed by coarse-grained sandstone (1 sample).

Graphic standard deviation (sorting). The values obtained from the samples range from 1.29 to 2.27 Φ (Table 1), indicating poorly sorted to very poorly sorted sandstones. The sorting degree indicates the hydrodynamic conditions (range of velocities and degree of turbidity) operating

within the transporting medium. To some extent, it is suggestive of the travel distance [17].

Skewness. Skewness is a measure of the symmetry of the distribution, i.e. the proportion of coarse or fine fractions. It is instrumental in describing the depositional processes of the sediments. The skewness values derived from the samples range from -0.01 to 0.15 Φ, i.e., nearly symmetrical to finely skewed, respectively (Table 1). The values obtained are indicative of a fluvial environment.

Kurtosis. The kurtosis expresses the peakedness of the grain size distribution. The kurtosis values

of the samples range from 0.80 to 0.96 Φ , i.e. from platykurtic to mesokurtic, respectively (Table 1). The samples analyzed show a dominance of mesokurtic sediments (7 pieces). Although, little geologic information is derived from kurtosis values [24].

Probability plots. The probability plots are of environmental significance. They are indicative of either fluvial, beach, or wave zone, according to [26] characterization. Two sand populations indicate a fluvial setting, three sand populations indicate wave zone bars, and four sand populations show a beach setting. The probability curves were plotted from the data obtained from the sieve analysis. This is actually established from the plots of the cumulative weight percent against grain size in (ϕ , Φ).

From the Cumulative probability distribution curves of the analyzed samples, it is observed that all curves have only two sand population distributions (straight line segments).i.e. saltation and suspension. Thus, indicating a fluvial environment. [26, 7, 25].

Bivariate grain size parameters. Graphic Mean, Standard Deviation, Skewness and graphic First Percentile are the parameters used to separate sands based on origin according to standard plots devised by various workers. These bivariate plots include the field of mean versus the first percentile, standard deviation versus first percentiles, and standard deviation versus mean [13, 19]. Plots for each bivariate plot show that 100 % of the samples fall in the river sand environment.

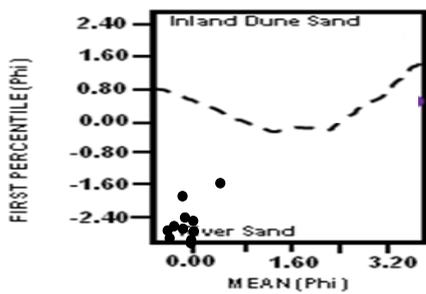


Figure 2 – Bivariate plot of first percentile versus mean

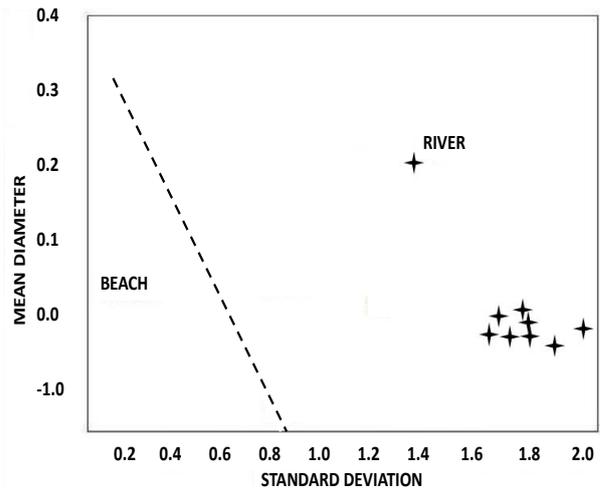
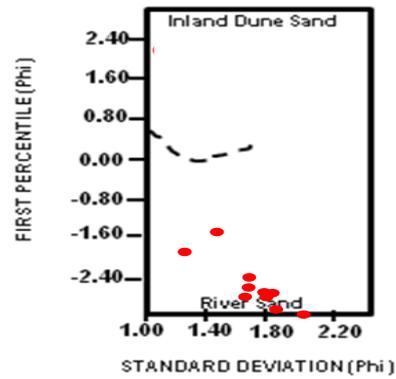
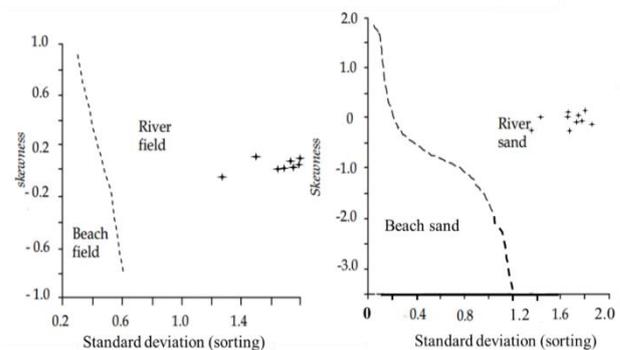


Figure 3 and 4 – Bivariate plot of the first percentile against Standard Deviation and mean against standard deviation



Figures 5 – Bivariate plots of skewness against Standard Deviation

Petrography

Textural characteristics. Description of chosen thin sections of the stanniferous sandstone with focus on grain size, sorting, roundness, sphericity and grain contacts shows in Table 3.

Table 3 – Description of chosen thin sections of the stanniferous sandstone with a focus on grain size, sorting, roundness, sphericity and grain contacts

Samples	Grain size	Sorting	Roundness	Sphericity	Grain contact
KA2	Very coarse	Poorly sorted	Angular –sub angular	Low sphericity	Floating grains dominate, and no sutured contact
CHR	Very coarse	Poorly sorted	Angular –sub angular	Low sphericity	Floating grains dominate, and no sutured contact
RYM1	Very coarse	Poorly sorted	Angular –sub angular	Low sphericity	Floating grains dominate, and no sutured contact
GMS 1	Very coarse	Poorly sorted	Sub angular	Low sphericity	Floating grains dominate, with few point contacts and no sutured contact
NGR	Very coarse	Poorly sorted	Sub angular	Low sphericity	Floating grains dominate, with few point contacts and no sutured contact
GMS2	Coarse	Poorly sorted	Sub angular-poorly rounded	Low sphericity	Floating grains dominate, with few point contacts and no sutured contact
BD2	Very coarse	Poorly sorted	Angular –sub angular	Low sphericity	Floating grains dominate, and no sutured contact
BD1	Very coarse	Poorly sorted	Angular –sub angular	Low sphericity	Floating grains dominate, and no sutured contact
TNT	Very coarse	Poorly sorted	Angular –sub angular	Low sphericity	Floating grains dominate, with few point contacts and no sutured contact
DG1	Coarse	Poorly sorted	Angular –sub angular	Low sphericity	Floating grains dominate, with few point contacts and no sutured contact

Point counting. This involves identification and recording the amount of monocrystalline quartz (Qm), polycrystalline quartz (Qp), (Qm and Qp make together make the total quartz Qt), feldspar (F), lithic clasts L, opaque minerals (Op), cement and matrix. The result of the point count is given in Table 4.

Sandstone classification. The results from the point counting (Table 4) were used to determine the relative proportions of quartz, feldspar and lithic fragments in Table 5.

Table 4 – Results of point counting of the stanniferous sandstone thin section of the study area

Samples	Qm	Qp	Qt	F	L	Op	Cement / Matrix
KA2	249	0	249	0	0	9	42
CHR	255	7	262	0	0	7	31
RYM1	268	12	280	2	2	4	12
GMS 1	253	0	253	0	0	3	44
NGR	226	0	226	0	1	16	57
GMS2	245	0	245	0	2	12	41
BD2	276	9	285	0	0	2	13
BD1	271	0	271	4	0	13	12
DG1	286	0	286	3	0	4	7
TNT	269	0	269	0	0	12	19

Table 5 – Recalculated parameters through point counting used in various triangular plots for the provenance and sandstone classification of stanniferous sandstone of the study area

Samples	QFL (%)				QmFL (%)			
	Q	F	L	Total	Qm	F	L	Total
KA2	96.5	0.0	3.5	100	96.5	0.0	3.5	100
CHR	97.4	0.0	2.6	100	94.8	0.0	5.2	100
RYM1	97.2	0.7	2.1	100	93.1	0.7	6.3	100
GMS 1	98.8	0.0	1.2	100	98.8	0.0	1.2	100
NGR	93.0	0.0	7.0	100	93.0	0.0	7.0	100
GMS2	94.6	0.0	5.4	100	94.6	0.0	5.4	100
BD2	99.3	0.0	0.7	100	96.2	0.0	3.8	100
BD1	94.1	1.4	4.5	100	94.1	1.4	4.5	100
TNT	97.6	1.0	1.4	100	97.6	1.0	1.4	100
DG1	95.7	0.0	4.3	100	95.7	0.0	4.3	100

These were plotted on QFL and QmFLt diagrams to investigate provenance and highlight possible differences in sandstone composition (Figure 7). The design of the sandstones was classified in ternary QFL and QmFLt charts following the descriptive terms of [24] (Figure 7 A-B). Additionally, the same values were plotted on ternary QFL and QmFLt diagrams similar to [5] to highlight the samples' provenance (Figure 7 C-D). For the QFL diagram, all quartzose grains are plotted together, monocrystalline and polycrystalline quartz. Contrarily, the QmFLt diagram only re-

gards monocrystalline quartz as quartzose grains. Thus, in the QFL diagram used in this study, lithic clasts and opaque minerals are considered lithic fragments following [5]. For the QmFLt diagram, lithic fragments include polycrystalline quartz and opaque minerals, which agrees with the QmFLt chart [5] and is similar to the classification [20].

In the QFL and QmFLt diagrams, all the samples are classified as quartz arenites (Figure 7 A-B). After [5], the samples indicate a craton interior and recycled orogen source area (Figure 7 C-D).

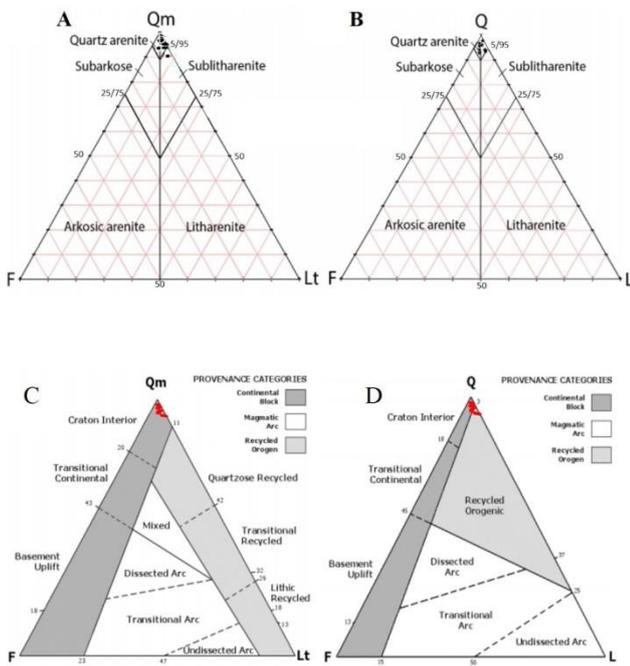


Figure 7 – QmFLt and QFL (A-D) diagrams showing the composition and classification, as well as the suggested provenance areas for the studied thin sections (A-B), modified from [24], while (C-D) are changed from [5]

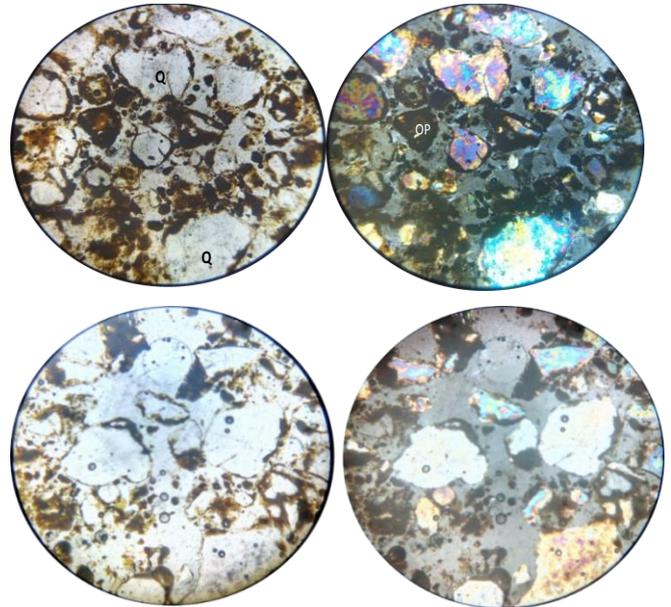


Figure 8 – Photomicrographs of some selected samples in plane-polarized light (PPL) and cross-polarized light (CPL) showing poorly sorted and poorly rounded subangular grains (mag 100x)

Notes: Q = Quartz, OP = Opaque mineral

Heavy minerals. The ZTR Index calculated from the result of heavy minerals analysis for the selected samples varies from 35% to 78%, with an average index of 59%. The ZTR indices suggest that almost all the locations contain immature mineralogical sediments and have a short distance of travel except sample NGR which indicates mature mineralogical sediment.

Table 6 shows ilmenite is the highest identified mineral, ranging from 3 to 27 %. Cassiterite is the second most identified mineral, ranging from 2 to 14 %, followed by zircon (2 to 16 %), magnetite (0 to 17 %), tourmaline (5 to 11 %), rutile (2 to 8 %) and monazite (2 to 7 %). The lowest heavy mineral occurrence is garnet, with 0 to 5%.

Table 6 – Heavy minerals within the cassiterite bearing (stanniferous) sandstone in the study area

Samples	Zircon	Tourmaline	Rutile	Cassiterite	Monazite	Magnetite	Ilmenite	Garnet	Others	Total	ZTR	ZTR Index, %
BD1	18	23	15	19	12	7	13	8	94	209	56	59
BD2	22	17	12	22	14	3	22	7	85	204	51	54
KA2	4	13	7	27	9	13	28	9	93	203	24	35
CHR	24	13	16	20	7	20	28	2	78	208	53	65
TNT	15	15	8	23	5	43	47	2	90	248	38	56
DG1	23	12	12	5	15	13	36	4	107	227	47	66
RYM1	33	15	16	22	6	24	12	10	69	207	64	63
RYM2	26	15	5	18	12	15	33	0	79	203	46	61
NGR	32	18	8	4	9	0	59	2	86	218	58	79
GMS2	29	15	4	27	12	0	5	4	93	189	48	53
Total	226	156	103	187	101	138	283	48	874	2116	485	59
Average	22.6	15.6	10.3	18.7	10.1	13.8	28.3	4.8	87.4		48.5	59

Table 7 – Percentage composition of heavy minerals within the cassiterite bearing (stanniferous) sandstone in the study area, %

Samples	Zircon	Tourmaline	Rutile	Cassiterite	Monazite	Magnetite	Ilmenite	Garnet	Others	Total
BD1	9	11	7	9	6	3	6	4	45	100
BD2	11	8	6	11	7	1	11	3	42	100
KA2	2	6	3	13	4	6	14	4	46	100
CHR	12	6	8	10	3	10	13	1	38	100
TNT	6	6	3	9	2	17	19	1	36	100
DG1	10	5	5	2	7	6	16	2	47	100
RYM1	16	7	8	11	3	12	6	5	33	100
RYM2	13	7	2	9	6	7	16	0	39	100
NGR	15	8	4	2	4	0	27	1	39	100
GMS2	15	8	2	14	6	0	3	2	49	100
Total	11	7	5	9	5	7	13	2	41	100

The granulometric parameters have proved to be good indicators in distinguishing paleodepositional environments where fossils are lacking, especially in a continental setting.

The texture of sediments provides information about the medium, mode of transport, and energy conditions at the deposition time. The coarse to very coarse-grained nature of the sandstones encountered, bivariate analyses, univariate grain size parameters and probability plots, and the absence of fossils and trace fossils suggest deposition in a low-energy fluvial environment.

The petrological studies revealed that the stanniferous sandstones have similar mineralogical compositions and lithology types, although with few variations. The studies showed that quartz is the most dominant detrital mineral averaging about 93-99%. This is an indication that the sandstones are compositionally matured and texturally immature. It also implies a high degree of chemical weathering and closeness to the source. The quartz grains have grain sizes ranging from coarse to very coarse. They are poorly sorted, sub-angular to sub-rounded, with low sphericity. This also indicates a closeness to the source and textural immaturity. The grain contact is dominated by floating grains, with few point contacts and no sutured contact. Most grains show the presence of iron oxide rimming their edges, inclusions, and vacuoles, which could be attributed to a low-temperature source such as a hydrothermal vein. Quartz is the common silicate mineral acting as cement in the analytes, although there are a lot of patches of iron-oxide glue. These cementing materials are chemically attached to the crystal lattice of existing quartz grains forming rims of cement (overgrowths). The mineral content of cement is silica and iron-

oxide. Feldspars were not observed in most thin sections, and the few presents have been significantly weathered, giving them a brown colouration. Very little feldspar suggests a slow sedimentation rate and a very high chemical weathering rate and indicates composition maturity.

The matrix is about 4 to 11% of the detrital fraction and consists of fine silty particles that appear brownish in some samples. This brownish colouration, coupled with the presence of iron oxide, is a strong indication of weathering and ferruginisation or probably due to percolation from the lateritic cover. Also, the reduction or oxidation process of the iron oxide may be responsible for this.

Judging from the ternary diagram, Both the QFL and QmFLt diagrams for sandstone classification indicates the dominance of quartz arenites, and following [5], the stanniferous sandstone samples are indicative of dominantly craton interior and few recycled orogen source area. Terrigenous sediments derived from the craton interior are more felsic, which explains why quartz minerals are more dominant.

From the study of the heavy mineral assemblages of the stanniferous sandstones of the studied area, it is found that zircon, tourmaline, rutile, cassiterite, ilmenite, magnetite, monazite and garnet occur persistently in all the studied samples. The heavy minerals were primarily derived from igneous and metamorphic rocks.

Opaque minerals (magnetite and ilmenite) indicate the chemical leaching of the sediments. Opaque minerals are mainly derived from crystalline igneous rocks, both acidic and basic. The higher proportion of opaque minerals indicates an igneous source. Therefore, the above study shows that the bulk of the heavies of the stannif-

erous sandstone are mineralogical immature and have been derived from igneous rocks and a little part from low to medium grade metamorphic rocks.

CONCLUSIONS

Stanniferous sandstones of the study area are dominantly angular to subrounded, coarse to very coarse-grained, poorly sorted, positively skewed, and mesokurtic sandstone. They were deposited in a fluvial environment by a low-

energy fluvial (river) depositional system, and the deposition in proximal (close to the source). The heavy mineral study shows that the stanniferous sandstone is mineralogical immature and has been derived mainly from igneous rocks and a little part from low to medium-grade metamorphic rocks.

Furthermore, the stanniferous sandstones are compositionally matured, textural immature, close to the source and have experienced a high degree of chemical weathering.

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The Effect of Double Rows Cropping Pattern with Corn on the Quantitative Characters of Some Varieties of Soybean in the Dry Land, Central Lombok, Indonesia

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Abstract. A field experiment was conducted in May-August 2021 on land in Central Lombok Regency for research purposes. The study's objectives are 1) to increase the Cropping Index from 2 to 3; 2) to know that soybean and corn varieties are in the tip and suitable for superimposing on dry land; 3) to improve the efficiency of dry land use so that it can be used as a reference for farming technology in Central Lombok Regency.

The results of the research showed that: 1) factors of a combination of planting distances in the double planting pattern with the interaction of various soybean varieties superimposed with corn are not significantly different; 2) fundamental differences in the various varieties with the most production yields of Kemuning varieties 1; 3) in the planting distance pattern of 50×20×15 cm with a soybean plant population of 266,608 trees, the production yield is 1.2 tons per hectare, and the corn plant population is 98,224 trees produced 7.3 tons per hectare.

Keywords: planting pattern; dry land; intercropping; quantitative character; corn; soybeans.

INTRODUCTION

Culturing several types of food crops, both in the form of rotation, intercropping, inserts and sequentially, will ensure the success of the farming business [1]. However, soybean plants with shorter plant architectures often experience shading stress, which is indicated by lower growth and yield [6].

Soybeans contain isoflavones which are antioxidants. This makes soybeans a priority food commodity programmed by the Ministry of Agriculture to meet the food needs of the Indonesian people [7]. This effort to meet soybean needs faces obstacles in the form of narrower fertile land. Therefore fulfilment can be carried out with a de-certification attempt. Diversification can be done by planting soybeans with a double crop pattern superimposed with corn after planting other food crops such as rice planting rice fields and dry rain in the central Lombok district. West Nusa Tenggara (NTB) is one of Indonesia's provinces producing soybeans and corn. In 2016 and 2017, it was ranked third after East Java and Cen-

tral Java. The biophysical characteristics of the land in NTB are suitable for the growth of soybean and corn crops due to water availability [4, 6]. Drought-tolerant soybean varieties can produce optimally according to their genetic potential when optimally applied to cultivation technology. The double crop pattern of soybeans superimposed with corn is one of the alternatives to increase the productivity of dry land in the Central Lombok district.

METHODS

This study used Split Plot Design (divided plots) to determine the quantitative characteristics of several varieties of soybeans with double crop patterns superimposed with corn. The main field with double row crops of several soybean varieties consists of 4 levels, namely:

B1 – Single Row with soybean row spacing of 40×15 cm;

B2 – Double Row with a row spacing of 70×20×15 cm;

B3 – Double Row with planting distance 60×20×15 cm;

B4 – Double Row with row spacing 50×20×15 cm.

The main field consists of several soybeans varieties: V1 – Kemuning 1; V2 – Pearl 2; V3 – Pearl 3; V4 – Sugentan 2; V5 – Gamasugen 2 with three replays each.

The linear model of the design used is:

$$Y_{vbk} = \mu + \alpha(v) + \beta(b) + \alpha\beta(vb) + \beta k + \varepsilon(vb)k, \quad (1)$$

where Y_{vbk} – observation value of varieties to b planting pattern too b on the k block; μ – general average value; $\alpha(v)$ – influence of v -to- v varieties; $\beta(b)$ – the impact of the b variety;

$\alpha\beta(vb)$ – the impact of the interaction between v and b double-row varieties; βk – the impact of the k block; $\varepsilon(vb)k$ – effect of error from double-line j and k block.

The data were analyzed with the F-test. If there is a real influence, it is continued to be analysed with the Duncan'S Multiple Range Test (DMRT). DMRT test to see the differences at the level of α 0.05. The regression test was carried out using Statistical Analysis System.

RESULTS AND DISCUSSION

Effect of Combination of Double Planting Patterns on Parameters of various soybean varieties overridden with corn is presented in Table 1.

Table 1 – Results of the analysis of the diversity of parameters of observation of vegetative and generative development of soybeans in Double Crops that are superimposed with Corn Crops

Factor	Diversity Observations Vegetative Parameters												Diversity Observations Genetative Parameters							
	Tall Plant (hst)			Sum Leaf (hst)			Sum Book (hst)			Sum Branch (hst)			Broad Leaf	Flower Age (hst)	Number of Stuffed Pods	Number of Hollow Pods	Number of seeds	Plot Weight	Weight of 100 seeds	
	30	60	P	30	60	30	60	P	30	60	P	60	30	60	Harvest (P)					
b×o	NS	NS	S	S	NS	NS	S	S	NS	S	S	S	NS	NS	NS	S	NS	S	NS	
v×o	S	S	S	S	S	NS	S	S	S	S	S	S	S	NS	S	S	S	S	S	

Notes: b×o – combination of Double Planting Pattern Planting Distance; v×o – Interaction of Various varieties of soybeans; S – Real Difference; NS – No Real Difference.

Table 1 is a summary result:

1. The effect of a single interaction on various varieties (v×o) on the pattern of double plants superimposed with corn showed no real difference (NS) in the number of books at 30 HST. The flowering period of 60 HST is when the plant is already 100 %.

2. From the explanation of points 1 and 2, the interaction of various soybean varieties on different double planting patterns superimposed with corn has a real difference effect on the quantitative characteristics of soybeans, both vegetative and generative growth. The influence of double planting patterns (b×o) on various soybeans varieties of soybeans can be seen in Figure 1.

Effect of Combination of Double Planting Patterns (b×o) on corn parameters on interaction with various soybean varieties (v×o) is presented in Table 2.

Table 2 is a summary result:

1. Interaction factor combination double planting pattern against each developmental parameter of the Real Different (S) at plant height (30 hst), while in other parameters. There is no real difference such as cob length, cob diameter, the number of seeds per cob, the weight of the seeds per cob, per plot seed weight and weight of 100 grains.

2) Interaction factors of various soybean varieties against single-anglers of corn crop parameters Differed Markedly (S) on plant height age (30 HST) and No Real Difference (NS) on other parameters. More details can be seen in Figure 2.

By sharing the single parameter, the effect of the combination of double planting patterns on various varieties of soybeans superimposed with corn can be analyzed on potential production yields, especially on the parameters of yield weight per treatment plot. It can be seen in Table 3.

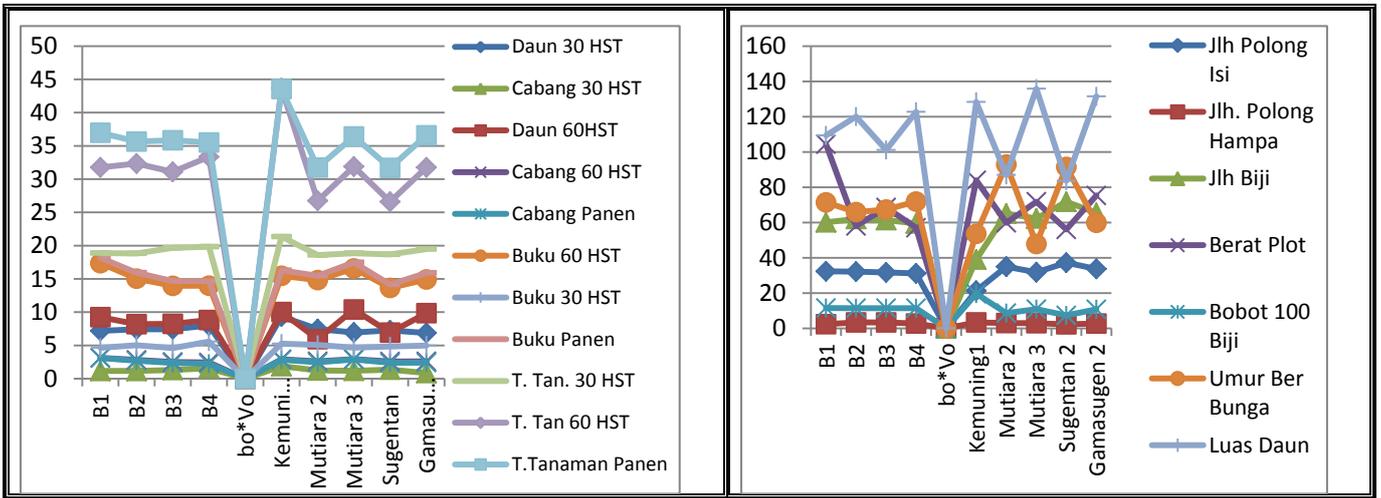


Figure 1 – ANOVA, Recapitulation of the Results of Observations of the Single Influence of Various Parameters of Soybean Plants Superimposed with Corn at the Age of 30 HST and 60 HST

Table 2 – Summary of the analysis of the diversity of observation parameters of vegetative and generative development of corn in Double Crops that are superimposed with soybean varieties

Observation of Age Gap of 30 HST, 60 HST, and Corn Crop Harvest										
Factor	Vegetative				Generative					
	Planting Height		Number of Leaves		Cob Length	Cob Diameter	Number of Cob Seeds	Cob Seed Weight	Heavy Seed Plot	Weight 100 Seeds
	30 HST	60 HST	30 HST	60 HST						
b×o	S	NS	NS	NS	NS	NS	NS	NS	NS	NS
v×o	S	NS	NS	NS	NS	NS	NS	NS	NS	NS

Notes: b×o – Combination of Double Planting Pattern Planting Distance; v×o – Interaction of Various varieties of soybeans; S – Real Difference; NS – No Real Difference.

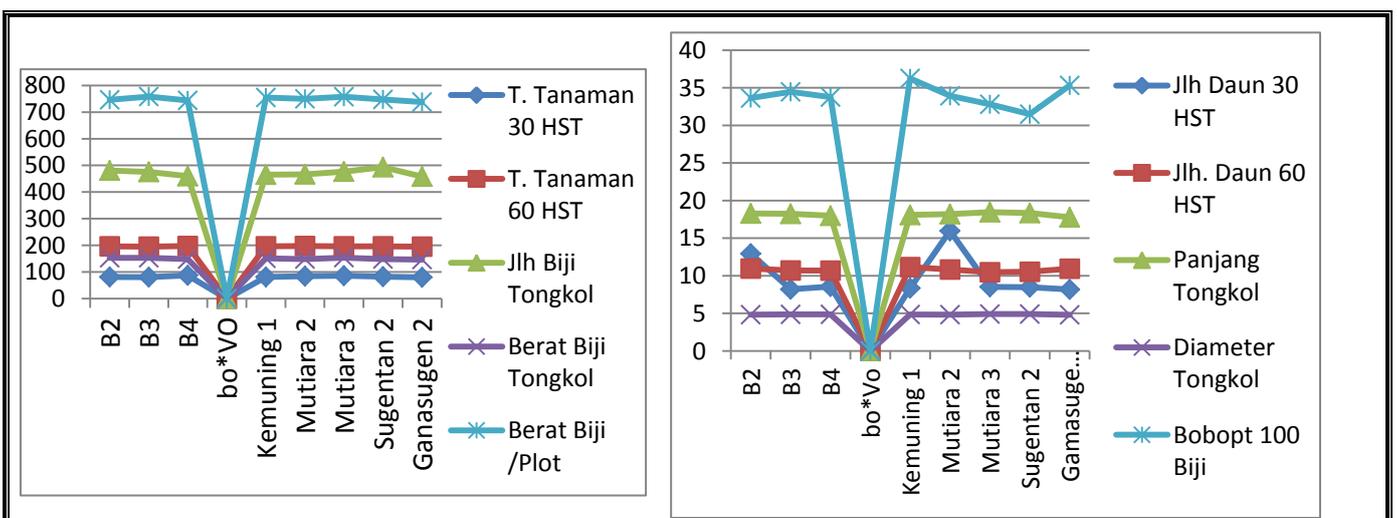


Figure 2 – ANOVA Results of Interaction Observations of Double Crop Patterns Superimposed with Corn on the Effect of Single Parameters on Corn Crops

Table 3 – Potential production yields combining double planting patterns (b×o) soybeans and interaction blended soybean varieties (v×o) stacked with corn

Factor	Data recapitulation of the results of Duncan's Multiple Test Sass 9.1 Advanced Test on Perplot Seed Weight						
	Seed Weight/ Plot				Production Potential (Ha)		
	M	N	R	D	Mp	Mph	Production (kg)
b×o	104.4	A	B1	S	280	245.560	1.281,82
	58.5	B	B3	S	304	266.608	779,83
	57.7	C	B2	S	304	266.608	769,16
	57.0	D	B4	S	304	266.608	759,83
v×o	83.91	A	V1	S	298	261.346	1.106,42
	75.28	B	V5	S	298	261.346	1.003,51
	71.83	C	V3	S	298	261.346	957,52
	59.88	D	V2	S	298	261.346	798,22
	56.02	E	V4	S	298	261.346	746,77

Notes: M – Mean (average); N – Notation; R – Rengking; D – DMRT; Mp – average population perpetak/plot; Mph – average population/acre.

In Table 3, it is explained that:

1) In the combination of double planting patterns planting pattern B1 (Single Row Planting) M=104.4 with notation (A); average plot population Mp=280 trees, declared Real Difference (S); with other double planting patterns so that the soybean population per hectare Mph=245,560 trees, the potential per hectare production yield = 1,281.82 kg; following the other Pattern;

2) while at the interaction of various soybean varieties, M=83.91 with the notation (A) expressed Real Different (S), where the sum Mp= B1; B2; B3 and B4) divided by 4, = represents the average interaction population of various soybean varieties (Mp) hence the Kemuning variety 1 (V1); Mp=298 trees, Mph=261,348 trees, with a potential production yield of 1,106.47 kg per bushel.

Table 4 – Potential production yields in a combination of double planting patterns (b×o) parameters corn and interaction of corn production yields grown with soybean varieties (v×o)

Factor	Data recapitulation of results of Advanced Test Sass 9.1 Duncan's Multiple Test against Corn per plot seed weight						
	Seed Weight/Plot				Production Potential (hectares)		
	M	D	R	N	Mp	Mph	Production (Ha)
b×o	758.05	A	B3	NS	84	84.192	6.237,41
	746.06	A	B2	NS	96	73.668	5.631,51
	743.71	A	B4	NS	112	98.224	7.260,47
V×o	757.35	A	V3	NS	97	85.069	5.657,33
	754.47	A	V1	NS	97	85.069	5.582,49
	749.70	A	V2	NS	97	85.069	5.471,03
	747.16	A	V4	NS	97	85.069	5.452,39
	737.67	A	V5	NS	97	85.069	5.394,41

Notes: M – Mean (average); N – Notation; R – Rengking; D – DMRT; Mp – average population perpetak/plot; Mph – average population/acre

In Table 4, it is explained that:

1) In the combination of double planting pattern against corn production, the planting pattern B4 (5×20×15 cm), M=758.05, notation (A), is stated

not significantly different (NS) from other patterns, where Mp=112 trees, so that Mph=98,224 so that the potential production yield is 7,260.47 kg of dry flat corn harvested per hectare, following another Pola.

2) while interacting with various soybean varieties then, the highest corn production was planted with Pearl varieties 3 (V3), $M=757.35$, notation (A) was declared Not Significantly Different (NS) from other varieties; $Mp=97$ trees, $Mph=85,069$ trees then the potential yield of corn = 5,657.33 kg dry Pipil corn harvested per hectare.

CONCLUSIONS

Based on the results of observations and discussions that have been carried out in this study, it can be concluded as follows:

1. The combination of double planting patterns (planting distance or plant population) can affect the significance of quantitative characteristics of various soybean varieties against vegetative and generative growth.
2. The double planting pattern and soybean varieties superimposed with corn affect the amount

of yield as follows: potential soybean yield in single plant pattern B1 (40×20 cm), plant population 245,560 trees/ha, production 1,281.82 kg/ha; while the double planting pattern B3 (60×20×15 cm), production 779,8 kg/ha, B2 (70×20×15 cm), production 769.16 kg/ha, B4 (50×20×15 cm), production 759.83 kg/ha with a population of 266,608 trees/ha of gonad planting soybeans. Medium varieties that are ideal to yield: Kemuning 1 – 1,281.82 kg/ha, Gamasugen 2 – 1,003.51 kg/ha, Pearl 3 - 957.52 kg/ha, Pearl 2 – 798.22 kg/ha and Sugentan 2 – 746.77 kg/ha.

3. In corn yields, the most ideal planting patterns for soybeans are: B4 (50×20×15 cm), maize population 98,224 trees/ha, production 7,260.47 kg/ha; B3 (60×20×15 cm) population 84,192 trees/ha, production 6,237.41 kg/ha and B2 (70×20×15 cm), population 73,668 trees/ha, production 5,631.51 kg/ha.

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Agronomic Appearance, Genetic Parameters of Red and Black Rice (*Oryza sativa* L.) in Different Environments Dry Land

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Abstract. Increasing yield and adaptability of brown and black rice in functional sub-optimal environments begins with increasing genetic diversity through conventional crosses between diverse germplasm. This study aims to determine the yield, genetic diversity, heritability, and interactions between rice genotypes in two different growing environments. The study was conducted in April-August 2021. The study was designed using a two-factor Randomized Block Design (RAK) with three replications. The first factor genotype consisted of 15 treatments, namely: 6 brown rice lines (G1-G6), five black rice lines (G7-G11), three the parents are Baas Selem (G13), Situpatenggang (G14), and GH Padi red rice (the elder of the brown rice line) and one comparison variety Inpago Unram 1 (G15). The second factor consists of two locations: Tampak Siring Village, Batukliang District (379 m a.s.l.) and Mujur Village, Praya Timur District (103 m a.s.l.) Central Lombok Regency. The results showed that the yield of Inpago Unram 1 (G15) was higher than other genotypes, namely 7.10 t/ha. The lines with the exact yield as the GH of red rice (brown rice strain parent) and Situ Patenggang (black rice parent) were G6 and G10 with a value of 5.21 t/ha and 5.35 t/ha, respectively. High heritability values were indicated by plant height and grain yield, while the other traits were classified as low to moderate with a range below 0.20 to 0.45. The coefficient of genetic diversity in the number of productive tillers was relatively high, namely 51.27%. Slightly low values were obtained for plant height and number of non-productive tillers with values of 38.63% and 48.26%, respectively. Developing G6 and G10 genotypes are recommended because they have higher yields. All tested genotypes were able to adapt to two different growing environments.

Keywords: genotype; diversity; heritability; interaction.

INTRODUCTION

Red and black rice are starting to be in great demand, considering that excessive consumption of white rice is a health problem [1]. On the other hand, the functional rice productivity of red and black rice is still very low. Therefore, it is necessary to improve genetic traits to obtain red and black rice varieties with high yields and early maturity. Breeding activities through crossing techniques produced genotypes of red and black rice [2-4].

The genotypes produced from red and black rice still need to be observed on the adaptability to different growing environments and the genetic parameters of their agronomic characteristics, such as the ability to inherit from the parents. Inheritance ability can be calculated through

broad-meaning heritability values to facilitate the following selection process. If the heritability value is high, it shows that genetic factors play a more role in controlling a trait than environmental factors and vice versa [2-4]. Another genetic parameter that needs to be observed is the coefficient of genetic diversity. This parameter is important because it can determine the uniformity of a character in a population. Therefore, studying red and black rice genotypes in two different growing environments is necessary.

MATERIALS AND METHODS

The research was carried out from April to August 2021 in two locations, namely in Jeranjang Hamlet, Tampak Siring Village (379 m a.s.l.) Batukliang District, Central Lombok Regency and in

Mujur Village (103 m a.s.l.) Praya Timur District, Central Lombok Regency.

The experiment consisted of two factors, namely genotype and location. Investigations at each site were designed using a Randomized Block Design (RAK), three replications. The genotype factor consisted of 15 genotypes, namely: 6 brown rice lines (G1–G6) and five black rice lines (G7–G11). Three parents are GH Padi Red Rice (G12) Baas Selem (G13), and Situpatenggang (G14), a comparison variety Inpago Unram 1 (G15). The second factor consists of two locations. Each plot measured 2×3 m with a spacing of 25×25 cm, and each planting hole was filled with two seeds and thinned to 1 grain per planting hole. Thinning was done on seeds that grew two plants in each planting hole and cultivated into one plant per planting hole. Thinning was done at the age of 14 days after planting. The difference test between treatments was carried out using the Duncan Multiple Range Test (DMRT) at a level of 5% [5]. Statistical analysis was performed using SAS software, while heritability analysis was based on [6], and the GFC value was based on [7].

RESULTS AND DISCUSSION

Rice plants can grow optimally at an altitude of 0–1500 m above sea level, a temperature of 23 °C, requiring rainfall between 1500–2000 mm/year. The measurement of a place affects the air temperature of a home. The higher the area, the lower the air temperature or the colder it gets. Conversely, the lower a place is, the hotter the air temperature.

The average rainfall in the two study locations, namely the East Praya sub-district and the Batukliang sub-district, respectively, was 75.55 mm³ per month and 98.33 mm³ per month [8]. According to [9], the threshold values used to determine the intensity of rain (mm/day) are 0 including cloudy, 0.5–20 including light rain, 20–50 including moderate rain, 50–100 includes heavy rain, 100–150 includes very heavy rain, and > 150 includes extreme rain. Based on the threshold value for determining the intensity of precipitation set by BMKG, the study location in East Praya District is classified as light rain intensity. In contrast, Batukliang District is classified as moderate rain. The height of the place was measured using an altimeter and google earth. It was found that the altitude for Mujur Village, East Praya Subdistrict, was 103 m above sea level

with a temperature of 23–28 °C and Tampak Siring Village, Batukliang District, 379 m above sea level with a temperature of 23–26 °C. The altitude of 103 m above sea level is classified as lowland, and 379 m above sea level is classified as medium plain. Medium plains have an elevation (elevation) of 300–700 m above sea level [10], while the lowlands have an altitude below 200 m above sea level. Both locations are central for upland rice cultivation in Central Lombok Regency's dry land.

In general, based on the analysis of variance, the environmental location factor had a significant effect on several variables, and there was no interaction between genotypes and location, as described in Table 1.

Table 1 – Summary of results of analysis of variance (ANOVA) on all parameters of rice plants as the effect of Genotype (G), Location (L) and Interaction between G×L

Observation Variable	Single factor		Interaction G×L
	Genotype (G)	Location (L)	
Plant height	*	*	Ns
Number of productive tillers	*	Ns	Ns
Number of non-productive tillers	*	Ns	Ns
Flowering age	*	Ns	Ns
Harvest age	*	*	Ns
Panicle length	*	*	Ns
Total Grain Fill/panicle	*	*	Ns
Number of empty grain/panicle	*	*	Ns
Grain weight/clump	*	*	Ns
Weight 100 seeds	*	Ns	Ns
Grain Yield t/ha	*	Ns	Ns

Notes: * – significant; Ns – non-significant

Based on Table 1, the genotype factors were significantly different for all observed variables. Location factors with different heights showed significant differences in plant height, harvest age, panicle length, number of filled grains per panicle, number of empty grains per panicle, and grain weight per clump. The difference was not significant for the location, indicated by the number of productive tillers, some non-productive tillers, age of flowering, the weight of 100 seeds, and grain yield. There was no significant differ-

ence for all variables in genotype interaction (G)×Location (L). This means that location does not affect plant growth in all tested genotypes.

Average agronomic variables per genotype are described in Table 2.

Table 2 – Average Agronomic Variables per Genotype

Treatment	ST	AP	ANP	UB	UP	PM	GI	GH	BGR	100 B	G t/ha
G1	100,703 fg	12,167 abcde	1.8333 a	82,667 cbde	114,167 a	21.2017 bc	103,785 bcd	25,463 ab	23,887 e	2,875 bcd	4.6260 dc
G2	117,993 ab	12,500 abcde	1000 abc	79,833 edition	111,500 ab	23,8250 a	110,020 bc	24,547 ab	35,525 bcd	3,101 a	3.7708 ed
G3	103,548 def	15,833 ab	1000 abc	83.333 abcde	111.333 ab	22.3533 abc	106,565 bc	24,907 ab	32,073 cde	2,871 bcd	4.7620 c
G4	109,830 dce	11,667 cde	1.5000 ab	83,500 abcde	111.333 ab	21.8883 abc	119,675 ab	24,842 ab	33,427 bcd	3,070 ab	5.0442 bc
G5	104,440 def	16,667 a	0.3333 c	79,333 de	113.333 ab	22,5600 abc	104,360 bcd	28,353 ab	35,228 bcd	2,920 abc	3.6368 e
G6	111,337 bcd	17,000 a	0.3333 c	84,167 abcde	111.333 ab	23.4617 a	119,010 ab	26,725 ab	44,532 a	2,941 abc	5.2115 bc
G7	103,718 def	10,000 e	0.6667 bc	85,167 abcd	114,167 a	20,3600 c	115,372 abc	20,722 bc	29,108 cde	2,738 cd	4.8230 c
G8	107,482 dcef	10,667 de	1.1667 abc	89,000 a	110,500 ab	20.5717 bc	119,862 ab	21,537 abc	26,690 de	2,678 d	4.7110 dc
G9	94,585 g	15,333 abc	0.1667 c	86,833 ab	108,333 ab	20.5533 bc	84,677 d	25,808 ab	33,047 bcd	2,908 abc	4.3760 cde
G10	111,278 bcd	12,667 abcde	0.3333 c	87,167 ab	109,333 ab	21.1600 bc	116,657 abc	20,880 bc	36,840 abc	2,718 cd	5.3562 bc
G11	107,580 cdef	17,333 a	0.6667 bc	84,000 abcde	108,667 ab	21.1083 bc	104,908 bcd	28,760 a	38,153 abc	2,876 bcd	4.7130 cd
G12	113,025 abc	16,000 ab	0.6667 bc	80,667 cde	107,167 b	21.8133 abc	121,528 ab	24,020 ab	33,762 bcd	2,833 cd	5.8162 b
G13	102.422 ef	14,333 abcd	0.0000 c	86,167 abc	109,667 ab	22.0783 abc	95,788 cd	27,527 ab	31,370 cde	2,771 cd	4.6087 cd
G14	106,162 cdef	18,167 a	0.0000 c	83,667 abcde	110,833 ab	22.7383 ab	115,573 abc	24,740 ab	38,300 abc	2,790 cd	5.3235 cb
G15	119,278 a	18,167 a	1.1667 abc	78,667 e	106,833 b	22.7867 ab	136,012 a	16,075 c	48.36 a	3,098 a	7.1020 a
Average	107.558	14.567	0.5000	83.611	109,644	20,381	104.919	24,327	31,842	2,879	4,925

Notes: TT – plant height (cm); AP – number of productive tillers per clump (stem); ANP – number of non-productive tillers per clump (stem); UB – flowering age (day); UP – harvest age (day); PM – panicle length (cm); GI – number of filled grains per panicle (grain); GH – number of empty grains per panicle (grain); BGR – weight of grain per clump (grams); 100 B – weight of 100 filled grains (grams); G t/ha: grain yield (t/ha).

*Numbers followed by the same letter in the same column are not significantly different according to the DMRT test at the 5% level.

Plant height between brown and black rice lines and parental and comparison varieties varied significantly between genotypes. The lowest plant is indicated by G9, with a value of 94.5 cm. G2 indicates the tallest plant with a value of 117 cm. This value was higher than the expected line, its parents and the same as the comparison variety Inpago Unram 1 with a value of 119 cm. Plant height in all lines ranged from 94 to 117 cm. The growth indicator or growth parameter

used to measure the effect of the environment on the applied treatment is plant height. The most easily observed growth measure is plant height. Plant height in several genotypes has a high diversity and will affect the yield. This is in line with the opinion [11] that the size of the plant stem is a trait or characteristic that affects the outcome. One of the causes of the diversity in the appearance of plant height is the difference in their genetic composition. This is by the opinion

of [12] that the variation in plant height between varieties is caused by each genotype having different genetic factors and characteristics.

The number of productive tillers for each genotype, red and black rice showed identical three genotypes with the parent G14 and the comparison variety, the genotypes were G5, G6, and G11 and the lowest number of tillers was indicated by G7. The number of productive tillers ranged from 10 to 17 stems per clump. According to [13], one of the causes of differences in the number of tillers that occur is genetic factors.

The number of non-productive tillers in each genotype of brown rice was G1 (two tillers), G2 (one tiller), G3 (one tiller), G4 (two tillers), G8 (one tiller), and G15 (one tiller). The range of the number of non-productive tillers tested was zero to two tillers.

The flowering age of each brown and black rice genotype is quite diverse. The flowering period of genotypes G2 and G5 was not significantly different, but flowering was faster than the other genotypes, namely 79 DAP. These genotypes flowered faster than all of their parents, but the same as the comparison variety - flowering age range from 79 to 87 DAP.

The G1 and G7 lines showed a more profound harvesting age than the GH red rice (107 DAP) and the comparison varieties (107 DAP). Harvesting age ranged from 109–111 DAP. The harvest age of the plant is related to genetic factors, so each genotype tested has a different period. This was revealed by [14] plant phenotypes will show physiological maturity, generally caused by genetic factors. Meanwhile, according to [15], the appearance that appears on plants results from the interaction between environmental and genetic factors.

The panicle length of the G2 and G7 lines was the same as that of the parents, and the comparison variety, with a panicle length of 24 cm. The number of filled grain per panicle of G4 (119.675 cm), G6 (119 cm), G7 (115.372 cm), G8 (119.862 cm), and G10 (116.657 cm) lines was the same as the parents and the comparison variety. The G13 line had a low number of filled grains per panicle with a value of 22.1 cm. Grain weight per clump of G6 (44.532 g), G10 (36.840 g), and G11 (38.153 g) lines were the same as Situ Patenggang parents and the comparison variety Inpago Unram 1. G6 line showed higher grain weight per

clump than parents Baas Selem with a value of 31.370 g.

The weight of 100 grains in lines G2 (3.101 g), G4 (3.070 g), G5 (2.920 g), G6 (2.941 g), and G9 (2.908 g) was the same as the comparison variety Inpago Unram 1. G2 line showed a weight of 100 grains higher than the elder. This indicates that there are genetic differences between genotypes. The results of this study are by [16], which states that differences in production can be caused by the genetic composition of each rice cultivar. The grain yield of red and black rice lines showed lower yields compared to the comparison variety Inpago Unram 1. The G4 (5,044 t/ha), G6 (5,211 t/ha), and G10 (5,356 t/ha) lines showed lower yields the same as its parents, and the comparison variety Inpago Unram 1.

Table 3 – Average of rice genotype agronomic variables per location

Variable	Location	
	Look Siring (L1)	Lucky (L2)
Plant height (cm)	109.30 a	105.81 b
The amount will be produced per clump (stem)	14.95 a	14.17 a
Amount of non-productive per clump (stem)	0.64 a	0800 a
Flowering age (hst)	84.53 a	82.68 a
Harvest age (hst)	108.28 b	111.00 a
Panicle length (cm)	22.33 a	21.46 b
Number of grain containing per panicle (grain)	115.72 a	107.44 b
Number of empty grains per panicle (grain)	30.04 a	18.60 b
Grain weight per clump (g)	36.30 a	32.18 b
Weight of 100 grains of grain contains (g)	2.91 a	2.84 a
Grain yield (t/ha)	5.04 a	4.80 a

Notes: Numbers followed by the same letter in the row are not significantly different according to the DMRT test at the 5% level.

Variables of plant height, harvest age, panicle length, number of filled grains per panicle, number of empty grains per panicle, and grain weight per clump, differed between the two locations. This shows that environmental factors influence the observed variables. At the same time, the variable number of productive tillers per clump, number of non-productive tillers per clump, age

of flowering, the weight of 100 grains of unhulled grain, and grain yields showed that there was no significant difference. This shows that environmental factors at two different locations do not influence the agronomic variables. The same research has been submitted by [3], which states the higher a place is, the temperature in that place will be lower, and the humidity will be higher. Every 100 meters above sea level, the temperature will decrease by 0.6 °C. However, the study's results were not the same as the statement of [3], where the plant height in the highlands had higher yields than in the lowlands. This is due to the different factors of rainfall and soil fertility in the two study locations, resulting in different results. According to [9], the threshold value used to determine the intensity of rain, the study location in Tampak Siring Village is classified as moderate rain with an intensity of 20-50 mm/day, and L2 is classified as light rain with an intensity of 0.5-20 mm/day. At the time of the study, L1 (Batukliang) was in rainy conditions while L2 (Fortunately) was almost no rain. This causes vegetative growth to develop rapidly at L1. Plant height growth at L1 was followed by other variables and affected the yield. In addition to rainfall, different soil fertility can also affect growth and yield. The results of laboratory tests of soil samples at two locations showed higher N, P, and K content at location L1. The test results at location L1 showed: N 0.09%, P 0.07%, and K 0.13% while at L2: N 0.08%, P 0.02%, and K 0.10% (Soil Laboratory, BPTP NTB in 2021). Plant height growth at L1 was followed by other variables and affected the yield. In addition to rainfall, different soil fertility can also affect growth and yield. The results of laboratory tests of soil samples at two locations showed higher N, P, and K content at location L1. The test results at location L1 showed: N 0.09%, P 0.07%, and K 0.13% while at L2: N 0.08%, P 0.02%, and K 0.10% [17].

Genetic factors also affect plant growth, besides being influenced by environmental factors, based on observations about plant height. This is evidenced by calculating the heritability value. The

following is explained further in Table 4 about the value of heritability on the observed agronomic characters.

Table 4 – The value of heritability on the observed agronomic characters

Agronomic character	Variety component		Broad heritability	Notes
	genotypic variance	phenotypic variance		
Plant Height	41.556	77.237	0.538	Tall
Number of productive tillers	7.469	16.513	0.452	Currently
Number of non-productive tillers	0.241	0.966	0.250	Currently
Flower age	8.678	29.027	0.299	Currently
Harvest age	3.349	26.519	0.126	Low
Panicle length	1.047	27.859	0.038	Low
Total Grain Fill / Panicle	13.353	275.087	0.049	Low
Number of Void Grain / Panicle	2.988	33.762	0.089	Low
Grain Weight Per Clump	27.512	47.695	0.026	Low
Weight 100 grains	0.013	0.041	0.317	Currently
Grain Yield	0.612	1.134	0.540	Tall

The range of heritability values is between 0–1. The heritability value is said to be high if it is close to 1 with a range of $0.5 \leq H^2 \leq 1.00$. The heritability value is said to be moderate if it is in the range of $0.20 \leq H^2 \leq 0.50$ and is said to be low if it is close to 0 with a range of $0.00 \leq H^2 \leq 0.20$ [18].

The results of research that has been carried out using fifteen genotypes in two different environments show that the heritability values for all variables are classified as low, medium, to high. High heritability values were indicated by two variables, namely plant height and grain yield (t/ha), with values of 0.538 and 0.540, respectively. High heritability values told that genetic factors played more roles than environmental factors in plant appearance. Productive tillers, non-productive tillers, and flowering age had moderate heritability values of 0.452, 0.250, and 0.299, respectively. Most of the other variables have low heritability estimates. The above shows that there are variations in the heritability esti-

mate value. The heritability expressed by [19] that characters included in the category of moderate to high heritability, meaning that environmental factors do not play a significant role in the appearance of these characters. Further stated by [20], a character with a high heritability predictive value indicates the influence of genetic factors is more significant than environmental factors.

In line with the opinion [11], heritability with a value of 0 means that phenotype diversity is caused by environmental factors, while a value of 1 means that genetic factors cause phenotype diversity. If the heritability value is high, the selection can be carried out in the early generations using mass selection methods or pure genotype selection. Meanwhile, suppose the heritability value is low. In that case, the choice is carried out in the next generation using the pedigree method, singlet seed descent, and progeny test to obtain new superior varieties. According to [21], high heritability values provide an essential role in the following selection process.

One of the successes in improving a plant's character is highly dependent on genetic diversity. A comprehensive genetic variety of research material is needed so breeders can choose research materials suitable for breeding purposes. It is further explained in Table 5 below.

Table 5 – GFC values for all rice genotype variables

Agronomic character	Coefficient of Genetic Diversity (KKG), %	Notes
Plant Height	38,636	A bit low
Number of productive tillers	51,271	A bit high
Number of non-productive tillers	48,267	A bit low
Flower age	10,379	Low
Harvest age	3,055	Low
Panicle length	5,137	Low
Total Grain Fill/panicle	12,727	Low
Number of Void Grain / Panicle	12,284	Low
Grain Weight Per Clump	3,826	Low
Weight 100 grains	0,452	Low
Grain Yield	12,420	Low

The grouping of genetic diversity according to [22], namely, KKG 0-25% belongs to the category of low genetic diversity, relative KKG 25-50% belongs to rather low genetic diversity, KKG 50-75% belongs to the category of low genetic diversity in rather high genetic diversity, and KKG 75-100% belong to high genetic diversity.

The observations of the tested genotypes on all quantitative variables showed that the coefficient of genetic diversity was relatively low, low, and rather high. The range of KKG values for characters with low and relatively low values is between 0.159–12.420 %. The low weight was indicated by the number of non-productive tillers, with a value of 48.267%. The variables of flowering age, harvest age, panicle length, number of filled grains per panicle, number of empty grains per panicle, grain weight per clump, 100-grain weight, grain weight per plot, and grain yield had low or narrow genetic diversity values. The character of the number of productive tillers showed a relatively high coefficient of genetic diversity with a value of 51.271%. Authors [23] stated that the coefficient of low to moderate variety could be categorized as narrow diversity.

CONCLUSIONS

The yield of Inpago Unram 1 (G15) variety was higher than other genotypes, namely 7.10 t/ha. The lines with the exact yield as GH Padi brown rice (the parent of the brown rice line) and Situ Patenggang (the elder of the black rice) were G6 and G10, with values of 5.21 t/ha and 5.35 t/ha, respectively. High heritability values were indicated by plant height and grain yield, while the other traits were classified as low to moderate, with a range below 0.20 to 0.45. The coefficient of genetic diversity in the number of productive tillers was quite high, 51.27%. Slightly low values were obtained for plant height and number of non-productive tillers with discounts of 38.63% and 48.26%, respectively. There isn't any interaction between Genotype (G)×Location (L); all tested genotypes were able to adapt to two different growing environments.

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The Best Practices of Commercialized Security on National Security in Nairobi County, Kenya

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Abstract. Commercialised security has grown and developed in Kenya. This is attributed to citizens' many security demands on the state. Hence they turn to commercialised security to complement. Despite this development, few studies have studied the best practices of commercialised security on national security. The study took on a cross-sectional survey design. It was done in Nairobi involving adult residents. A multistage sampling technique was employed to obtain the wards to be studied. Those managing or purchasing the commercialised security services for their establishments and the managers of commercialised security firms were purposively sampled. The general public and the security guards were systematically sampled. Questionnaires and scheduled interviews were used to collect data. The SPSS version 25 was employed in data management and analysis. In the research, descriptive statistics included percentages and frequency distribution tables to summarise variables into thematic areas and convey the characteristics of critical variables. The study identified five best practices of commercialised security on national security: improvement in working conditions of the security personnel, adequate training and development, cooperation with the state security agencies, after-sale service and enforcement of regulations. The study concluded that the favourable mechanisms could only be realised through the consultation of the stakeholders: the commercial security industry, the citizens and the state. Thus the study recommended that The Private Security Regulation Authority needs to implement some of the requirements in the PSRA No. 13 of 2016.

Keywords: commercialised security; commercialised security services; manned guarding; alarms and electronics; CVIT; investigation; best practices; national security.

INTRODUCTION

The views of Max Weber influenced the provision of security as the most vital obligation of the state. The 'Weberian State' monopolised the legitimate use of physical violence [35]. Accordingly, the state is accountable for delivering internal security and defence from external dangers.

However, the state establishments are limited in warranting fairness in the circulation of security to all the citizens and visitors to the society [7]. Consequently, the state focuses on delivering security to its vital investments and some subjects. At the same time, the other citizens and their assets are allocated in one fit suit despite their diverse security requirements. The citizens' different security needs place many demands beyond the state's capability, making it challenging for equal distribution of security services [7]. Therefore, various actors are explicitly considered to

enhance the source of security services. Perhaps, the most important of these actors is the commercial security industry (CSI), which has expansively grown in several countries. Several studies have correlated the growth and expansion of commercialised security markets with deficiencies in the ability of nations to deliver security-related services [2; 10].

Commercialised security comprises enterprises that provide some aspect of security/policing services with a profit motive [39]. Commercial security is also described as fee-paying services intended to protect people and physical assets [7; 41].

Due to their bestowed trust in security provision, the industry can be involved in a decrease or an increase of the peoples' feeling of being safeguarded. Therefore, their activities are confronted with the need for best practices to enhance

people's and their property security. In essence, the best practices in the industry prompt individuals to seek services to protect their valued property. Since then, the CSIs have been engaged in various services, including manned guarding, alarms, cash and valuables in transit, correctional facilities management, security consulting, pre-employment screening, systems integration and direction, and information security. Notwithstanding, some critics of the commercial security industry have even maintained that the sector consists of illegitimate actors; hence it cannot be legitimate [28]. They recommended banning the commercial security industry and ensuring that the state takes up all the security and military operations within its borders. Consequently, this provided the impetus for finding out the best practices of commercialised security on national security in Nairobi County, Kenya.

In the USA, the CSIs have been involved in many services, including manned guarding, alarms, cash and valuables in transit, correctional facilities management, systems integration and management, security consulting, pre-employment screening, and information security [32]. But the extent of the best practices they are involved in might not be practical to the Kenyan context, which is what this study is about.

The precise dimensions of the extent and progress of the Australian security sector came after the trend in the international scene of considerable advances in security services during those last three decades of the 20th century because of two main factors. First was the market claim, partially responding to sudden increases in crime from the 1960s and the continuing high levels of crime, according to [37]. However, the information on the best practices of commercialised security in Australia is limited. Commercial security firms (CSFs) personnel in Australia are associated with controlling crowds, guarding and patrolling facilities, risk management, court security, gathering evidence, and case investigation [39]. However, inquiries into the commercial security industry conducted by the Australian Crime Commission and the New South Wales Independent Commission against corruption identified harmful practices. These include the potential for criminal activity and the infiltration by organised criminal gangs [36]. This raises the question of whether there are best practices of commercialised security for Australia's national security.

In Africa, the CSI are in most countries, including South Africa, Nigeria, Tanzania and Kenya. The expansion of CSI in South Africa can be attributed to the escalation of crime [4]. Commercial security personnel now outnumber public police in South Africa [11]. In Nigeria, the commercialised security industry has been able, to some extent, to supplement the activities of the police in the management of security despite the challenges confronting them [1; 17]. The total number of commercial security guards in Tanzania is close to 1.2 million, compared to less than 1 million police officers [31]. The Tanzanian police force, therefore, collaborates with the CSI to offer security services to government buildings and institutions such as forex bureaus [31]. Commercialised security in Africa appears to be used to enhance national security. Still, there is a shortage of knowledge on which best practices enhance the industry's impact on national security.

In Kenya, the increase in crime and the advance of the commercialised security industry is pegged on the decline of state capacity, which began in the late 1980s and continued to the 1990s [22]. In this era of deteriorating economic affluence in Kenya and many African countries, state expenditure and investment reduced drastically to conform to Washington Consensus. Commercialised security appears to be an outgrowth of increased security demands, making it difficult for the states to offer protection to their citizens [10]. This would therefore suggest that commercialised security was envisaged to complement the state efforts in keeping a safe world in different regions. However, insecurity remains a concern of many nations despite the expanded commercial security industry. Therefore, this raises questions about the effect of commercialised security on national security, which is premised on the social contract. However, despite the philosophical differences that provide security models, there is limited empirical knowledge on the best practices to enhance the impact of commercialised security on national security.

Recent studies conducted in Nairobi on commercialised security have consistently focused on the development and growth of commercialised security, but with restrained reflection on which best practices enhance the impact of commercialised security on national security in Nairobi County, Kenya. A study was conducted on the factors affecting the performance of commercial security firms in Nairobi County [31]. The study showed that security conditions in the country

would significantly improve with a well-regulated CSI and appeared to allude to the importance of a well-regulated industry. Still, it falls short in providing a holistic explanation of which best practices enhance the impact of commercialised security on national security in Nairobi county, Kenya.

Another study that examined commercialised security services and crime control in Nairobi County pointed out that citizens opt for commercial security firms (CSFs) for their security needs [24]. The CSFs are seen to be able to tailor their service to each particular customer, unlike the public security agencies who serve the community collectively. The extent to which these tailored security services, as a best practice, enhance the impact of commercialised security on national security is left unaddressed in the study. In addition, the study revealed that the government needs to regulate the CSI's roles as security providers to achieve oversight and control over them. This could imply that some of the services offered by CSI may not be aligned with national security, thereby creating a need to study if regulations were best practices that would enhance the impact of commercialised security on national security.

Further, another study was conducted on how the availability of commercial security services assists in crime control in Nairobi County [29]. The study identified five categories of crime control services: alarm response, mobile patrols, residential security, security surveillance in marked security vehicles at strategic points, and regulating public access control to buildings. Despite these security services, insecurity is still experienced in Nairobi. Consequently, the need to understand best security practices to eliminate insecurity.

Literature Review

Security practices tend to take up many diverse appearances regarding the subject being secured, the threats involved, the tactics being followed, and the players implementing these tactics. If we assume that security practices can take a variety of different appearances, then their impact on the safety of people is also likely to differ. Accordingly, security practices have inadvertent implications, partly because the customers of security practices may interpret and receive them in different ways [7]. These positive or negative effects

are little understood by customers, providers and researchers alike [7]. For this reason, the study proceeds from an informed understanding of the security practices being pursued when commercial security is engaged.

For the manned guards to carry out their jobs efficiently to impact the overall national security, their physiological, economic and social aspects need to be satisfied: job satisfaction [23]. Hence, the managers of manned guarding services should know the job satisfaction of the guards and cultivate the practices that will increase the guard's job satisfaction [23]. A guard's job satisfaction ensures they are effective, impacting national security. The current study sought to establish the best practices that would enhance the impact of commercialised security on national security.

Cash and valuables in Transit robberies attracted the most significant number of robbers, depending on how complicated the theft is [40]. The study was to develop results to guide CVIT prevention policies for this valuable economic sector. Its data was gathered from 40 respondents using structured and semi-structured interviews. It is highly recommended that CVIT guards rotate their responsibilities and shifts to erase being predictable in safeguarding the cash and valuables of people and businesses. However, this study proposed to explore the impact of the rotation of responsibilities and shifts by the CVIT crew to erase being predictable on national security.

Indeed, in South Africa, where CSFs have that long-distance cash and valuables in transit, it is a requirement for them to inform the state security agencies to keep surveillance on their armoured vehicles using unmarked police vehicles [15]. This works well when the CVIT crew are aware of the unmarked cars. However, this management system of surveillance has its grey areas, where the crews transporting cash and valuables have noticed unmarked vehicles tracking them without any confirmation that they are surveillance police cars. The guards fear that robbery is about to occur [15]. This is a best practice to safeguard the CVIT crew and goods despite its flaws. But Gumedze does not inform how the CSI's surveillance of CVIT services is a best practice that impacts national security positively. Therefore, this study proposed to explore the best practices of surveillance of CVIT services on national security.

The aim of investigating an offence is to gather evidence and identify those who committed it by being unbiased and impartial [20]. Also, an investigator is to seek and establish truths regarding some event or crime through objective and impartial pursuance [14]. Furthermore, investigators guided by ethics and integrity will seek facts and evidence to establish the perpetrators of criminal activity, track them and have proof beyond reasonable doubt [16]. Commercial investigators also occupy an important place in the justice system due to their competency and integrity for the customers [36]. The above highlighted best practices of impartiality, objectivity, unbiasedness and integrity, as Joubert, Gardner, Hess and Orthmann and Prenzler and Milroy have sought to explain the best practices of commercialised security investigation. However, they have not been informed on the impact of those best practices of commercialised research on national security, which this study will strive to achieve.

In contrast, Morgan and Rotunda have been cited arguing that some commercial investigators are unscrupulous, using techniques and tactics that violate the Model Rules of Professional Conduct and dangerously exposing themselves and their customers to civil cases and, at worst physical harm [13]. It is referred to as pretexting, which generally means disguising the identity and intentions of the investigator when approaching a subject to extract information [13]. An example is some commercial investigators hiding a tracking device on the subject's vehicle, which they can print out [13]. In the USA, this technique is criminal under federal and state law due to the insecurity it causes to the citizens and the violation of privacy laws [13]. While Morgan, Rotunda, and Forrest have expounded on the practices that are not the best in the commercialised investigation, they could not shed light on how these practices impact national security.

A study on promoting commercial security firms' self-regulation developed a familiar context for examining how consumers influence through choice, voice, loyalty and exit [25]. By taking the United States government as an illustrative example, the analysis observed encouraging security industry self-regulation through consumer power [25]. The finding was that the consumers of commercial security services would help facilitate and enforce professional standards by shifting their customer loyalty to CSFs, which have signed up to codes of conduct or certification

schemes. However, the study did not propose how the consumers' power in coercing the CSFs to self-regulate would impact national security. Similarly, another study recommended organising, coordinating, operating and partnering mechanisms for an operative partnership concerning courtesy, accountability and pleasant relativity amongst security stakeholders: police and commercial security firms [42].

Accordingly, the benefits of training and development of guards bring about better performance, efficiency and output, directly or indirectly benefitting the customers [19]. However, the study did not discuss how it impacted national security, which is what this study sought.

A study on private security guards' job retention determinants found that government-approved minimum wages, career progression, and job security were some of the best practices that improved the working condition for the security guards [33]. Similarly, on the incentives as determinants of job retention among the private security guards in Kenya, career development, income, and job security were some of the best practices that improved the working conditions for commercial security guards [34]. But the studies did not discuss how those best practices impacted national security, which is what this study is about.

The literature review shows the competencies, evolution and challenges, duties and functions, limitations and best practices of commercialised security. However, studies did not address the impact of the best practices of commercialised security on national security, which this study aimed at addressing.

Theoretical Framework

The Network Analysis theory guided this study by analysing and interpreting the best practices of the commercialised security industry on national security in Kenya and worldwide.

The basic premise of network analysis is that, in addition to the character, beliefs and interests of actors, the relations among a set of actors: their preferences, policies or resource exchanges, have a significant impact on how they interact and on the outcomes of these interactions [8]. In particular, in networks involving different actors, for instance, state security agencies and the commercial security industry, coordination is frequently

complicated by differences in values and interests. It may therefore require more direct negotiation [30]. For example, the value of state security is in the common good, while commercialised security's value is in the customer who pays for the services. This could create coordination challenges as the CSFs sometimes want to be specific and provide disintegrated protection in an area (for instance, focus only on the premises that have subscribed for their services). Decentralised networks, on the other hand, allow for the making and implement security policies that enable localised action and autonomy [3]. Since security varies from region to region, how state security agencies interact with commercialised security players will vary too from region to region. The outcomes of these interactions will also vary. This forms the basis of how the relations are formed, either formal or informal, stable or unstable.

METHODOLOGY

A cross-sectional design was adopted for the study, as different respondents were studied simultaneously. It gives a more substantial likelihood of participation. It also helped to gather objective information that was used for generalisation to a larger population. The design also fits diverse experiences into predetermined response categories.

The research was carried out in Nairobi County, where the capital of Kenya sits, and most CPFs have their headquarters. Stratified sampling was used to cluster the target population into homogeneous groups as:

Consumers of the commercialised security services:

1. Those who buy or manage commercial security services for their organisations. These are primarily security managers and officers, and
2. The general public.

And the providers of commercialised security services:

1. Those who are working as operations/heads of security.
2. Those who work as static security guards and mobile security guards.

The study used Krejcie and Morgan's table to determine the figure to be sampled. The study population fell under N 100,000; therefore, the sam-

ple size was 400. The respondents were clustered as: consumers (n = 200), and Providers (n = 200).

The consumer respondents of commercialised security services were divided into 50 security managers/officers and 150 from the general public who have experienced commercial security services in functions or venues. Likewise, the providers of commercialised security services were divided into 50 operations/heads of security and 150 working as static security guards and mobile security guards.

The research targeted 114 commercial security firms in Kenya. There are 76 listed security firms at the Protective Security Industry Association, and 38 listed security firms at the Kenya Security Industry Association, in Kenya [26; 38]. The researcher used multistage sampling to determine the sample size and the respondents.

The study used structured questionnaires (completed by the guards of the CSFs, and the general public) and one-on-one interviews with open-ended questionnaires (with the top management members from both CSFs and the consumer organisations/facilities). The researcher delivered the questionnaires to the security firm's offices and picked them up within three days. Follow-up calls were made to ensure success in filling in the questionnaires. Out of 400 questionnaires administered to the interviewees, 374 were declared valid as they had no errors.

The data were analysed using Statistical Package for Social Sciences software (SPSS version 25, 2017). The interpreted data was then summarised using percentages, ratios, frequencies and measures of central tendency. The rates and ratios were important for comparing similarities and disparities at different levels. Multiple regression was done where further statistical analysis was required. There was the ethical consideration where the researcher informed all participants of their voluntary participation, confidentiality, and relevant authorisation from government agencies.

RESULTS AND DISCUSSION

This section presents, analyses and interprets data related to the study. Studies have shown that the commercial security industry is involved in practices with unintended consequences on their customers, partly because the customers

receive and interpret them differently [7]. These practices may assume many guises, depending on the facilities and assets being secured, the threats being engaged, the strategies pursued, and the security firms implementing them. These practices may positively or negatively impact the customers and national security [7]. Therefore, it was essential to investigate the best practices by

the commercial security industry which would enhance national security. The findings are presented in subsections discussing the best practices captured from the data collection. Study respondents were asked to identify the best practices by commercialised security to enhance national security. The recognised diverse best practices are shown in Figure 1 below.

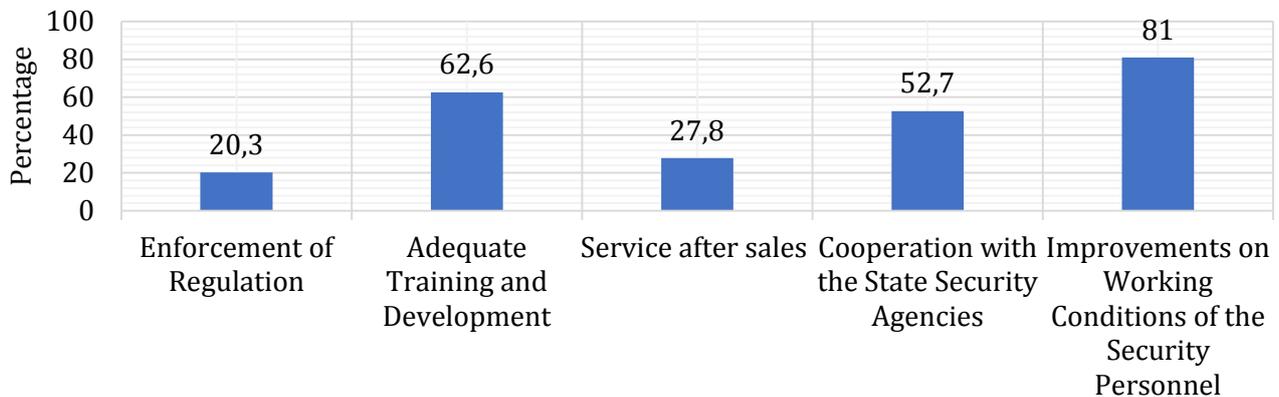


Figure 1 – Best Practices to Enhance the Influence of Commercial Security on National Security

Improvement on Working Conditions of the Security Personnel. Improved working conditions of commercial security personnel were the most mentioned, with 81 % (303 respondents) saying it. It was felt that it leads to satisfactory service delivery to their customers. One general public respondent pointed out that.

"The improvement of their places of work can be a booster to their morale. Let the security personnel feel they are in a conducive working environment, for example, a decent guard house, to work better."

A consumer security supervisor in a government building had this to say.

"It is satisfying to see a security guard you have been with for a long time being promoted and given other responsibilities. That is a real booster even to others. But when the guards do not see their colleagues or themselves being promoted, that can be demoralising."

A security guard pointed out that.

"If we can be paid the minimum wages according to the government set standards, it would boost our working conditions."

According to the responses, improved working conditions in the commercial security industry are influenced by 'prettifying' the physical work-

ing environment, possibilities of career progression and improved wages.

The work environment should be tailored to provide some comfort and ease for the security guards who are the users. This translates to them being easily connected to their work and work environment. This also improves their work productivity which translates to better security for those using the security services. Such a "prettified" environment compensates for the lack of proper working tools and can, therefore, positively impact a guard's performance, affecting their security service delivery. Also, Even the slightest attempt to fulfil the physiological aspects of the security guards' workplace will contribute significantly to their perception of being rewarded by their employer or customer [23].

In career progression, there is a need for fairness and equal treatment on promotion and persistent elevations. These reforms need to happen at a much faster pace to improve performance. Promotion is a significant achievement in life as it delivers and promises more pay, responsibility, status, authority, and independence. The opportunity for promotion directly affects the overall performance of the security guards as they undertake their security duties. In the long run, there is better and improved customer security delivery. This can be reinforced by Victor

Vroom's Expectancy Theory which links effort, performance, and outcome [43]. Therefore, an employee believes that the higher the reward, the more action and better performance. Similarly, a study found that career progression/promotion was a best practice that improved the working condition of security guards [23]. Likewise, another study alluded that career development is a best practice that enhances the working conditions for commercial security personnel [34].

Most respondents mentioned improved wages as a significant factor contributing to improved working conditions in the commercial security industry. It was recommended that commercial security guards should be paid salaries which are within the minimum government requirement and in sync with the country's inflation rate to safeguard the income that is being depended upon to make the day-to-day running of the guard's life, including food, clothing and shelter. The security guards should also be aware of the country's minimum wage to empower them to complain to the appropriate officials whenever they are salaried below the stipulated rate. Improved income as a best practice improved the working condition of the security guards [33]. Similarly, improved income is a best practice that enhances the working conditions for commercial security personnel [34].

Likewise, improved income improved the working condition of the security guards [27]. This finding reinforces Abraham Maslow's theory of hierarchy of needs which states that, for most individuals, a job offers a potential avenue for the aims they desire to accomplish in life and the impact they hope to create in the community.

Improved wages are moderated by PSRA No. 13 of 2016 to guarantee the reimbursement of minimum earnings and compliance with principles meant to inhibit misuse or exploitation of workers in the commercial security industry. This ensures that the industry does not become a source of insecurity for the persons employed. Also, the implication of this constitutional article is to ensure that gratified guards serve the customers.

In the long term, work environment/space, career progression and improved wages might increase the guard's performance in securing people and their assets. In turn, this feeds positively into national security.

Adequate Training and Development. Insufficient Training and Development for the security personnel was the second most mentioned by 234 (62.6%) as a best practice. Commercial security firms provide a massive source of occupation for many interested in pursuing a career in security. The certificate of training and development principles, therefore, has a consequence on the quality of security service delivery. One general public respondent explained that.

"The security guards are joining the industry without any other prior experience. Therefore, they need to be trained adequately and given certificates when they pass, just like in any other profession."

A security manager in charge of security in an international organisation pointed out.

"When we contract a security firm to provide services, we participate in the one-week refresher training that the guards undergo before taking up duties in our organisation. We have to make sure that the training is adequate and that the guard is 'ripe'"

A manager of a sizeable commercial security firm had this to say.

"The customers have higher expectations on the quality of their investment. Therefore, our training standards are stringent in that, out of 50 candidates, only approximately 30 get to qualify after the training."

A manager of a small-sized commercial security firm had this to say.

"Training schools have the advantage of instilling an organisation's culture. It also gives the security guards lifelong basic security training. So we understand our handicap by the lack of the facility."

The training and development of the skills of the security guards are the most critical factor for the success of securing the public. The CSFs should initiate training and development over and above the basic training standards and provide certain types of supplementary training: public relations training, first-aid training, fire response drills, premise and facilities evacuations, and night duties orientation training. Security guards who have undergone adequate education and development have abilities to be aware of potential threats and have ways to overcome them. Moreover, through education and training, security guards can identify the risks and provide the proper way to handle the threats [19].

The security guards should be taken through training before being assigned, which is the foundational training for the security guards, in general, to instil in their consciousness of the security attributes, engagements or procedures they are duty-bound to take to minimise the customer's vulnerability to danger or other factors that may compromise their security. These include such features as taking details of the visitors and informing them of their presence and authority to either allow them in or not, communication on how to operate telephones and walkie-talkie sets, recording of motor vehicles that are coming in and out of the premises plus the details of the driver, report writing, first aid, self-defence, skills of observation and surveillance, and last but not least booking in the assignment Occurrence Book any incidents that have taken place. Training security guards articulates their powers and limitations when in the field and therefore requires frequently looked over and made up-to-date to fulfil progress and expansion [21].

Security guards must be cut above the rest in today's modern world. On numerous occasions, security personnel accesses places or rooms that most people would not be permitted or acquire after-hours admission when locations are otherwise unoccupied. They must be trained and instilled in them an ethical compass to assist them in adopting correct and moral decisions when no one is watching. Continuous training and development would have benefits such as efficiency and other factors that relate directly or indirectly to the security guard's performance, making them more unlikely to make mistakes that would put public safety at risk when faced with unruly situations [19].

Continuous and development training includes attitudes towards employees, operation of each department, parking regulation (for instance, the usage of security certifications) and traffic and access control regulation. This would also ensure a continuous updating of the skills of the security guards on the latest crime practices and anti-crime techniques, enabling them to be adequately skilled. This would translate to better security and safety for the customers and the nation.

During the specialised training security education, the security guards would gain specific skills for particular jobs, including cash and valuables in transit, emergency alarm response, and body guarding. They will understand doctrines, con-

cepts, and realities to progress their logical and problem-solving abilities in those specialised skills. Security guards are the sentinels in any organisation and hence need continuous training [21]. They are the implementers of policies and laws within the organisations. They are the crucial components of peacekeeping inside the premises of organisations.

The PSRA, No.13 of 2016, moderates the training of the commercial security guards by setting the standards and accredits institutions offering training and development. This guarantees superior training, particularly regarding the monitoring and auditing of the quality of training and development functions performed by accredited persons and institutions. The Act also appropriates sensible acts to validate the legitimacy of training certificates offered to provide security services in the country. In general, therefore, Private Security Authority has to ensure that commercial security firms maintain specific training and development standards.

Cooperation with the State Security Agencies. Cooperation with the state security agencies was the third best practice mentioned that can enhance the impact of commercial security on national security by 197 (52.7%) of the respondents. Despite their differences, state security agencies and commercial security firms have similar plans to fight crime. A manager in charge of operations in a security firm is enlightened.

"Cooperation benefits begin when individuals in both the commercial security industry and state security agencies find they can do their jobs more efficiently and effectively due to the professional contacts they have created amongst themselves."

A security guard expounded.

"We are the eyes and ears of the police on the ground, and the police promptly respond when we call upon them. The benefits of such cooperation trickle down to the customer and the general public."

The professional contacts created through cooperation assists in security provision networking. Such networking achieves benefits of exchange of knowledge and experiences through social gatherings and lecture platforms by the security professionals at police training and vice versa. New security professional contacts are among the cooperation benefits experienced. The connections identify who can get what done in their respective security areas of responsibility and may de-

velop records of specialised skills, for example, a private investigator in background checks, a first aid instructor or a fire and emergencies instructor.

Some commercial security personnel appreciate that, on the ground level, security officers' increased cooperation with police positively influences their confidence as they know that the police will respond promptly to their distress and emergency calls. State security agencies, in turn, appreciate the "extra eyes and ears" they gain by working more closely with commercial security guards. The state security agencies more often have information and intelligence that they pass on to the security guards. While commercial security guards are in charge of vulnerable locations and identifying the threats and dangers, which they inform the police as they have access to intelligence from multiple field offices nationwide. It was acknowledged that a collaborative and consultatory tactic amongst the state security agencies and commercial security industry was a force multiplier in delivering communal security and deterring criminality [41]. Similarly, Joh is quoted as observing the notion that commercial security can assist as "equal partners with the state security agencies in the co-production of security, rather than simply as lower ranked providing an accompanying service" [39].

These benefits increase when the cooperation as a group forms trust, takes on definite purposes, and experience achievement as a consequence of combined efforts. Hence, the cooperation can be viewed as a reflection of mature principles of security, whereby the national security agencies and the commercial security industry work collectively to fix the crime-control and security plans and, after that, execute them.

After-Sale Service. Customer satisfaction is essential nowadays, and this can be achieved through after-sale service. After-sale service was recommended by 104 (27.8%) of the respondents. It shows how security firms are committed to providing quality products and services to their customers. Customer satisfaction should be one of the primary objectives of security firms. A manager of a bank explained it.

"Challenges are very dynamic, and as the customer, I am the one who knows where the shoe pinch. Despite a security provider's expertise, it would be good if they listened to me and customised their service according to my changing needs. There-

fore, I expect to interact with them often after procuring their service and goods."

An operation manager of a security firm had this to say.

"We may have the right knowledge, gadgets and experience in security. But the customer knows the specific challenges they are going through. We interact with them through customer visits, allowing us to continue offering service after sales. In our organisation, service after sales is part of the reports that every operations manager has to make. This ensures that the customer still feels that they are well protected using our services and products."

Security firms must provide better after-sale services to guarantee that their consumers are content with the services and goods they procure. After-sales service ensures that any defects are rectified, any breaches are sealed, and any weaknesses are strengthened. This way, the customers feel satisfied, and there is an overall feeling of security.

After-sale service increases demand for services and products, and the firm's brand reputation rises. An increase in brand reputation means that a security firm has to maintain high-quality standards in all its operations, including recruitment, training, deployment, supervision and customer feedback. The repercussion is that the means of security services and goods are enhanced. Enhanced security services and goods lead to increased demand for commercial security services. In the long run, this trickles down to more coverage of the country by the commercial security industry. This coverage expands the visibility of the security personnel and devices, which are a deterrence to criminality and harmful activities, and enhances national security.

In a study on market-based management, it was also reiterated that the main aim of after-sale service is to pay attention to what transpires afterwards when the customer is subscribed to advance an enduring association that can assist the customer and the security firm [6]. Similarly, it has been expressed that after-sale service is a vital constituent of rivalry centred on how a product or service fits or surpasses a customer's desires and anticipations [5]. The customer wants to be comprehensively secured and protected, whereas the security firm wants to continue making a profit by selling its products and service. Therefore, when the customer's security

needs and expectations are met, the ripple effect is the enhancement of national security.

Enforcement of Regulations. For a nation to benefit from the services and goods offered by the CSI, it has to ensure that procedures guide the industry. Enforcement of the PSRA No. 13 of 2016 was a concern of 76 (20.3%) of the respondents. A general manager of a security firm advised.

"The CSI is a sector intertwined with national and non-governmental actors and requires a national approach to regulating. The current legal framework should be put to work to control the industry."

A senior administrator at a non-governmental organisation posed.

"The Act is good and can streamline the industry, but only if the authority can enforce what is in the Act. Let us wait and watch as the authority puts its house in order."

Due to the potential implications arising from intertwining among national actors, non-governmental actors and the CSI, there is a need for efficient enforcement of regulations and controls. Such substances include breaching their customers' privacy and contractual stipulations. If implemented, the current regulatory framework in this industry would provide a strong deterrent to the abuse given the inclusion of penalties and can significantly impact how the CSFs operate. Developed mechanisms to ensure effective oversight of commercial security ensures that commercial security firms are not exposed to syndicates, dishonest and/or improper behaviour [32].

There should be enforcement of follow-ups or periodic checks on registered security guards and security firms. Individual security guards should be deregistered or deactivated after a definite period of being inactive in the industry. The mix of active and passive security personnel within the commercial security industry and the constant movement between them influence the capability of the sector to shield itself from criminal elements. It also influences the capability of the sector to contribute positively to the overall security of the citizens and the country. The enforcement will also ensure that the customers, security guards and security firms are protected from exploitation. There was a need to protect consumers by ensuring they receive the quality of services they are paying for, which are significant and costly [12]. At the same time, the com-

mercial security industry must be regulated for safety reasons so that it is not vulnerable to unethical and/or illegal behaviour [45].

Similarly, regulatory standards should be updated to protect the industry's employees [9]. On the other hand, there should be advice on regulation to protect the public from unscrupulous and unqualified security practitioners [32]. The regulation and licensing of the industry would give it legitimacy, hence expanding the security provision in the nation [44].

The network analysis theory categorically informs that security needs vary from one commercialised security customer to another. Hence, coalitions of interest form amongst security firms and their customers to help determine security policies. The coordination that proceeds from within these particular policing arrangements: temporary or permanent, may need an arbitrator to ensure that the security policies of the coalition of interests do not fail.

Although the best practices in the commercial security industry can be numerous, the study established that enforcement of regulations, adequate training and development of after-sale service, cooperation with the state security agencies and improvements in working conditions of the security personnel as the best practice for the industry. There is a need to engage in a transformative change of attitude from the regulator, the security firms, the security personnel and customers. Group effort is needed to instil and sustain these best practices to help to enhance and strengthen national security. It is paramount to seek and include all the stakeholders in the best practice process because they may improve the situation.

The study sought to investigate the best practices to enhance the impact of commercialised security on national security in Nairobi County, Kenya. Data from the fieldwork established that there were several best practices, with the improvement of working conditions of the commercial security personnel being the first. It includes acts like the 'prettifying' of the physical working environment, possibilities of career progression and improved wages. Even the most minor attempts to fulfil the psychological aspects of the security personnel contribute significantly to the overall performance of their security duties.

The study found that continuous training and development would increase efficiency and make

the guards less likely to make mistakes that would endanger others. Training and development would increase guards' performance efficiency, resulting in better security for the subscribers.

It was also revealed that cooperation with the state security agencies would produce networking benefits like exchanges of knowledge, experiences and specialised skills. Security guards would have increased confidence on the ground level due to the formed contacts. The state security agencies would also appreciate the "extra eyes and ears" on the ground by working more closely with the commercial security personnel.

The study found that after-sales service rectifies any defects and seals any breaches that the consumers may have noticed with the products and services procured. It also increases demand for security services and products. Consequently, high-quality standards in the security of goods and services and increased demand for security services translate to a positive national security input.

Last but not least, the study revealed the need to enforce PSRA No. 13 of 2016, as commercialised security is intertwined with national security. Such would help to ensure that the industry is not a source of insecurity to the communities it operates from and the people it secures. In the long run, it would help in sanitising the industry and assisting it to contribute positively to the overall security of the country.

CONCLUSIONS

Based on the discussion, the study concludes that commercialised security though motivated by profit-making plays a significant role that enhances state capacity in providing protection and contributes to citizens' safety. Therefore, contrary to popular belief by some scholars, commercial security displaces insecurity in other areas. This study found that commercial security engages in some best practices which edify security, creating feelings of safety for the customer buying the services and the surrounding environments [18]. This significantly contributes to safeguarding people (citizens and visitors) and their property, leading to freedom that teaches social and economic development. The possible networking between commercialised security and state security can offer effective security if the commercialised security in Kenya is effectively legitimised and regularised. Accordingly, the collaboration between different actors in security, in this case, the state and non-state actors, holds the potential of pooling resources together and coordinating actions in pursuit of safety. Therefore, based on the findings, this study argues alongside other scholars [3, 8, 25, 30] that characterising a network of actors with a common goal can create links to help them pursue shared interests and values (reduction and elimination of insecurity).

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